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H. Sandaff

REMARKS

ON THE

DRILL HUSBANDRY,

BY WHICH

THE SUPERIOR ADVANTAGES OF THAT MODE OF
CULTIVATION ARE POINTED OUT;

AND ITS PROFITS ASCERTAINED,

FROM ACTUAL EXPERIMENTS:

ALSO,

A COMPARISON OF IT WITH THE MOST APPROVED
METHODS OF

BROADCAST HUSBANDRY.

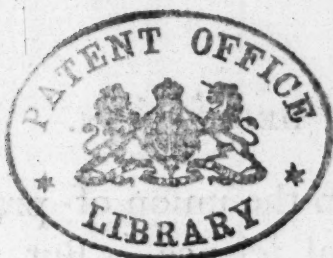
BY SIR JOHN ANSTRUTHER, BART.

LONDON:

PRINTED FOR T. EGERTON, AT THE MILITARY
LIBRARY, NEAR WHITEHALL.

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TO THE

K I N G.

10. 11. 09.

SIRE,

NO period of the British History has been more distinguished than YOUR MAJESTY'S Reign for its excellence in the Liberal Arts: They have been fostered by Your care, and encouraged by Your munificence. But Your attention has not been confined to these alone, it has extended to the useful, as well as to the elegant Arts; and while Painting and Sculpture flourished under Your patronage, Your zeal for the happiness of Your people, gave to the useful art of Agriculture the highest encouragement: Societies have been formed for its advancement, and a Board of Agriculture has been instituted under Your immediate Protection, from whose labours we may hope for every thing that can be expected

expected from the union of practical skill and theoretical science. But its greatest encouragement has been derived from Your Royal example. What can be more flattering to a people than to see in its Sovereign the best practical farmer in his dominions, encreasing the means of their subsistence, directing the skill, and stimulating the industry of others by His example.

The following pages are humbly laid at YOUR MAJESTY'S feet, with a view of calling the public attention to a fair comparison between the different modes of husbandry.

That they may not prove totally unworthy Your perusal, is the utmost ambition of

YOUR MAJESTY'S

Most dutiful and loyal Subject,

JOHN ANSTRUTHER.



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PREFACE.

I Was induced to enter into the enquiry, and to make the experiments and remarks which form the subject of the following pages, in consequence of an accidental conversation with a friend, who wished to have some information concerning the nature of the Drill Husbandry.

Mr. Tull, who is the father of the system, has left several Essays upon the subject, which have been so little attended to, that the most mistaken opinions are entertained, not only with respect to his system itself, but with regard to the actual mode of cultivation which he followed. It has been supposed, that his system led him to reject the use of manure altogether; and the fact of his having raised successive crops of wheat, with advantage and profit, upon the same ground, was so little believed to be possible, that even the intelligent Philip Millar says, “ he practised this method
“ of sowing the same species upon the same ground,
“ till his crops failed, and they were worse than
“ his neighbours.”

I was myself, not intirely without the same prejudices against Mr. Tull's system, and was therefore not a little surprised when the circumstance I have mentioned led me to look into his Essays, and attend to the facts which he advances in support of his system. So far from discountenancing the use of manure, he expressly advises it: and so far from the fact being true, that he continued successive crops of the same species till they were worse than his neighbours; he positively asserts in his last publication, that he had 120 acres of drilled crops, which in the twelfth successive year produced equally with any field he had. Finding this contradiction between the commonly received opinion of his system, and the fact as stated by him, I was led to look into other authors; and try some experiments upon the subject.—A considerable part of his theory turns upon the fact of the great produce to be had from a single grain when a sufficient space and air is given to it. In order to ascertain this, I had it tried first in a garden, where from a single grain of wheat, to which I allowed a space of three feet square, 52 ears of wheat were produced, and 2180 grains; and with 84 grains per yard, or 28 per foot, 100 ears were produced per foot, or 300 per yard; as I have formerly stated in Vol. III. of the Bath Agricultural Society's papers.

After

After thus ascertaining one of the grounds of his system, I then tried whether it was possible to raise successive crops of wheat without manure; and for this purpose selected an acre of ground, which was in such a state as to require much cleaning in the ordinary course of husbandry: by making my experiments on this sort of land, I not only ascertained the possibility of raising successive crops of wheat upon the same ground, but ascertained that the drilled husbandry answered the purpose of cleaning the ground equally well as a crop of turnips in the ordinary course would have done—These experiments were continued for a course of four years; and although liable to some uncertainty from the badness of the machine, which rendered the sowing very unequal, yet when the crop came to be reaped in those places where it was tolerably evenly sown, the produce per annum was equal to from 24 to 28 bushels per acre. The success in this led me to try a variety of other experiments.

I know of but few who have tried any experiments in this mode of agriculture. In 1767 the Society of Arts gave a premium to Sir Digby Legard for his experiments: since that time it has been tried by Mr. Crack, and the Rev. Mr. Dean: their success places this mode of cultivation in so favourable a point of view, that I can only impute its not being in general use, either to the prejudice I have already mentioned, or the want of the necessary

cessary machines. The last of these difficulties is removed by the invention of Mr. Cooke's drill plough, which is well adapted to drilling in equidistant rows. Since which other machines have been constructed equally proper for horse-hoeing. If Mr. Tull's first method be found to be successful, the intelligent farmer will be induced to try his second, which promises equal advantage to the public and the farmer, by the increase of the quantity of grain in the kingdom, without having recourse either to fallow crops or to importation. If the following Remarks, which originated from the accident already mentioned, can advance so desirable an end, the wishes of the Author will be fully gratified.



EXPERIMENTS AND REMARKS

IN

DRILL HUSBANDRY.

10. 11. 07,

CHAP. I.

GENERAL PRINCIPLES OF TILLAGE.

MR. TULL says, "Tillage is breaking and dividing the ground by instruments, as dung does by fermentation; and since the artificial pasture of plants is encreased by pulverization, it is no matter whether that be effected by dung, or by the attrition of the plough.

"It is evident, however, by dung we are limited to the quantity we can procure; but by tillage we can enlarge our field of subterraneous pasture without limitation."

"Tillage as well as dung is beneficial to all sorts of lands.

"Light land being naturally too porous, which is the cause of its lightness, when it is by any means broken and divided, the parts come nearer to one another, and it becomes for a time, bulk for bulk heavier: and strong land, being less porous than it ought to be, by a good division and separation of its parts, is made for a time lighter.

"Artificial pores cannot be too small, because the surrounding parts being soft and yielding, roots easily
B enter,

enter, and enlarge them: on the contrary, natural pores are too minute, and their surfaces too hard, for the free entrance of roots.

“ Insufficient tillage leaves strong land with its natural pores too small, and its artificial pores too large, and light land with its natural and artificial pores both too large.

“ Pores that are too small in hard ground will not easily permit roots to enter them: pores that are too large in any sort of land can be of little use to roots, but to give them passage to other cavities more proper for them.

“ Fibrous roots can take in no nourishment from any cavity, unless they come into contact with, and press against the surface of that cavity.

“ From these principles, it follows, that the finer land is made by tillage, the richer it will become, and the more plants it will maintain; and this inference is confirmed by experiment; for it has been often observed, that when one part of a field has been better tilled than the rest, and the whole managed alike for six or seven years; this part which was but once better tilled, has always produced a better crop. This is fully confirmed by the testimony of various authors. For instance, Mr. Evelyn says, “ Take “ the most barren earth, pulverise it well, and expose “ it abroad for a year incessantly agitated, and it will “ become so fertile as to receive an exotic plant, and “ cause all vegetables to prosper in the most eminent “ degree.”

“ This artificial dust,” he adds, “ will entertain “ plants that refuse dung.”

“ It is demonstrably true, that one cubic foot of this minute powder may have more internal superficies than a thousand feet of the same earth tilled in the common manner; and in fine soil, the most tender roots have free passage to their utmost extent, whereas in hard ground, they find too much resistance.”

I shall

I shall mention what a very intelligent writer and practiser of the drill husbandry says, and the reason he gives for the produce of this husbandry. Mr. FORBES on the extensive Practice of the new Husbandry.

“ It is found by experience, that the deep or horse-hoeing husbandry enriches the land, not only to produce a single crop of wheat, but to so great a degree, that successive crops are obtained upon the same land. This is an uncommon circumstance; for successive crops of wheat cannot be obtained in the common husbandry, even with the assistance of manure.

“ That land is impoverished in some degree by every crop, all farmers allow; and they endeavour to restore its lost fertility by tillage, fallowing and manure. They do not apprehend tillage and fallowing alone will recover it, and here no manure is used.

“ Whence then is the land recruited with vegetable nourishment, and this not only without being impoverished, but on the contrary is found to become more fertile by this tillage well performed, though it bears a crop every year.

“ This recruiting of the soil is not the consequence of tillage and hoeing; these do divide, break and pulverise the soil. But breaking, dividing and pulverising the soil are mechanical operations, they add no new matter to the land, and are therefore so far of themselves from enriching the land, that they only prepare it for the roots of plants to run and extend in it more freely, which instead of enriching the land only prepares it to be more readily exhausted of its fertility. For the more pabulum, or the more nutritious aliment the roots draw from the land, the poorer the land becomes, and the less stock of nourishment is left in it to support the next crop.

“ Tillage, therefore, ploughing, harrowing and
B 2 hoeing

hoeing add nothing to the fertility of the land. This helps to nourish the plants, yet does not add to the fertility of the land, but only prepares it to be more quickly exhausted of vegetable nourishment.

“ It appears from experiments that the leaves of plants imbibe air and moisture, but the principal source of vegetable food is universally allowed to be derived from the earth. Whence plants receive their nourishment chiefly by means of their roots.

“ If the earth were dense or solid, the roots of plants could not penetrate into it to collect nourishment.

“ The roots of plants are of different degrees of strength. Beans and oats penetrate into close strong land better than barley; and top-rooted plants push their top roots deep in the ground; but their lateral or side roots, as of carrots, are slender and weak, yet are the carrots or top roots nourished by the weak lateral roots.

“ For when weak lateral roots are able to penetrate and extend, as in light land or soil, the top roots grow strong and penetrate deep into the land. But in strong soils, where the lateral roots are confined by hard close earth, and they cannot extend, the top roots also suffer, and are unable to penetrate deep. But if the strong land is lightened, and kept open by good hoeing, not only the lateral roots are at liberty to range, but the top roots are strengthened, so that they penetrate into the earth below.

“ It appears from these and many other cases, that plants receive their nourishment principally by means of their fibrous or small roots. But whence are the roots supplied with this nourishment? Some think that the earth is recruited of this nourishment by manure. But what recruits the land that is not manured, and yet continues to bear annual crops? This is therefore the great point to be considered, the discovery of which will explain the true system of vegetation

getation and principal foundation of the new husbandry. Some have supposed that the roots feed upon the fine particles of the earth; but this cannot be admitted, as large plants would carry off so many tons every year, the richer land would soon be exhausted. We must therefore endeavour to discover elsewhere the genuine source of the vegetable nourishment.

“ The earth is surrounded by a fluid body commonly called the air, or atmosphere, which consists of all sorts of matter, of air, water, salts, oils, fire and earth.

“ All volatile matter lighter than air ascends and composes that body, called the atmosphere, and being in contact with the earth must have great influence upon it.

“ Rain and dews contain the vegetable nourishment in considerable quantities, and is by them introduced and deposited in the soil. If the soil be loose and porous, they introduce it to a considerable depth as in light land, but stiff loams and clays being more close and compact, the rain and dews do not so easily penetrate into them, for which reason such close lands are enriched by them near the surface *only*.

“ Hence it appears the richness of the land does not consist in the nature of the soil itself, but in something extraneous that adheres to it, that is communicated to it by the atmosphere, and that it may be divested of it by the roots of plants, for it seems to adhere closely to the particles of the soil.

“ It is observable that it is enriched by the atmosphere in proportion to the nature and quality of the finer parts of it, for all land is not equally enriched, though equally exposed to the atmosphere.

“ The sheer sharp lands in many places appear to be incapable of attracting, or receiving the vegetable food, for they continue barren for ages, though they

they constantly are exposed to the atmosphere, as do also the shifting sands of Norfolk."

The effects of the method of deep horse-hoeing corresponds with the above, which is also Mr. Tull's practice. That of pulverizing and often hoeing admits this influence of the atmosphere to sink deeper in land that is kept fine, than in hard rough land.

And the common practice confirms this remark; for farmers find by experience that once ploughing for barley, or wheat, will not produce such good crops as when frequently ploughed, and some of the best farmers give more tillage to their land than formerly they did; but this pulverizing is of still more benefit when continued through the year, as it not only continues it in that state which it has attained by frequent tillage before sowing, but more effectually destroys the weeds, which rob the broadcast farmer's crop of a great deal of the nourishment.

How far dung has the enriching quality imputed to it of bringing richness to the land, I shall not take upon me to dispute; or whether it is only the fermentation it occasions, that pulverizes the soil, as lime does, although there is no enriching quality in it, I leave to others to decide, and only quote facts, from which every one may draw his own conclusions.

However wrong Mr. Tull may be in some part of his Theory (which is a subject we shall not enter upon) where in his chapter of Food of Plants, he endeavours to prove that the food of plants is earth; yet his experiments shew the effect of that manner of husbandry.

His experiments, and that of others who have practised this new mode, being the subject of these remarks, are sufficient for the practical farmer, to induce him to make trial to judge what is most his interest to follow.



CHAP. II.

OBJECTIONS TO THE DRILL HUSBANDRY.

THE drill husbandry has been generally rejected by mere practical farmers, from an opinion, that the design of Mr. Tull's system was to set aside the use of manure; and manure they found to be so necessary in their mode of husbandry, that they looked on a system which rejected it, as ridiculous, and too whimsical to merit attention.

They could not believe that successive crops of wheat could be raised on the same land without manure, which they found impracticable even with it; and, being accustomed to sow so much seed by broadcast on a given portion of land, they would not be convinced, that so small a quantity as is sown in the drill could produce so great a crop as the broadcast mode of sowing, looking upon the empty *spaces between the drills as lost*: They imagined also, that the expence of the drill husbandry was greater than that of sowing by broadcast, and the profit less: because the drill husbandry required greater skill in the farmer, and more nicety in the execution, of course could not be performed by common servants or labourers. Besides, they pretended in this kingdom, that drill ploughs were expensive and difficult to be procured; that being slightly constructed, they were liable to be broken, or put out of order, and in most parts of the country, could not easily be repaired.

These difficulties co-operating with the prejudices
of

of the farmers, have not only prevented the practice of the drill husbandry from becoming more general, but deterred many persons from making such experiments as would have convinced them of its superior advantages. I mean therefore, in this treatise, to shew plainly, by fair experiments and observation, that the mode of sowing in drills is not only most productive, but less expensive than any other system hitherto adopted.

CHAP. III.

MR. TULL'S OPINION OF THE USE OF MANURE.

THERE cannot be a greater mistake than to imagine that Mr. Tull rejected the use of manure. So far from denying its use, he expressly says in many parts of his works, that it is highly useful. The following quotations will clearly shew what was his opinion on this subject.

After mentioning the bad effects of manure in the garden, in giving the roots a bad taste, he adds:—" Yet a considerable quantity of it is so necessary to corn fields, that without it little good can be done by the old husbandry."—Again, " Tillage alone is not sufficient for many sorts of grain, especially wheat. Dung without tillage can do very little, with some tillage it doth something, with much tillage it pulverizes the soil in less time than tillage can alone do; but tillage alone, with more time, will pulverize the soil as well. It is necessary in the old Virgilian system, yet

yet to most sorts of land used in the old and new pulverizing husbandry, it is not necessary, as appears by mine, and by the experience of all farmers who have made proper trials; they find as well as I, that the effect of dung may be supplied by increase of tillage.

“ But I have never said any thing against the use of dung in the corn fields, except where the whole expence of it is likely to exceed the profit.

“ That dung may be useful, when properly applied, I believe was never denied by any author. On the contrary, to give every sort of land proper and sufficient tillage, and to use only what dung we have, or can reasonably get, is that husbandry which I call antivirgilian, of which my horse-hoeing scheme is a species.

“ Such plants as cabbages, turnips, carrots, and potatoes, when designed for feeding cattle, will not be injured by dung, tillage and hoeing all together, which will make the crops greater.

“ Few fields can have the conveniency of a sufficient quantity of dung, to enable them to produce half the wheat those will do near cities, where they have plenty.

“ I have made many trials of fine dung on the rows, and notwithstanding the benefit of it, I have for several years last past left it off; finding that a little more hoeing will supply the effect of it, at a much less expence than that of so small a quantity of manure, and of the hands necessary to lay it on, with the carriage.”

The booksellers were suspected of encouraging persons to write against his book, in order to bring it into discredit, because he sold it himself. Many of his opponents wrote uncandidly; he takes notice of their misrepresentations, and adds, “ The vulgar in general, believe, in a part of the country not twelve miles distant, that I carried my dung to the river and threw it in: but it is known, that I neither sell nor waste any:” and again, “ The reader sees how falsely

it hath been published to the world, that I assert in my essays that dung is uselefs."

Mr. Duhamell's Husbandry, translated by Mr. Mills, contains a great many experiments of the drill culture, and comparisons of it with the broadcast, with and without dung. At Acow 2 arpents both dunged, were cultivated, the one in the new, the other in the old way. The arpent cultivated in the new way produced 150 bushels,* or 3150lb. that in the old mode, $133\frac{1}{2}$ or 2800lb. Thus the produce of the former exceeded that of the latter by $16\frac{2}{3}$ bushels, or 350lb. making a clear gain of one eighth. To this must be added 8 or 10 bushels saved of seed; the profit will then amount to $24\frac{2}{3}$ bushels or 518lb. On calculating the produce of the 2 arpents for 3 years; the arpent cultivated in the old manner will yield but $177\frac{7}{8}$; whereas that cultivated in the new method will produce 450 bushels: thus, besides saving the seed necessary for a crop of oats, and the expence of one year's fallow, there will be a clear profit of 272 bushels.

He calculates in the common method of that country, one crop of wheat after a fallow, and one of oats, and supposes a crop of oats to be equal to one third of a crop of wheat.

In another experiment at Denamvillieu, one arpent was sown in the common way with 10 bushels of seed. This had been very well dunged; another was sown with the drill plough, 3 rows of wheat in a bed, 2 feet wide, and a space of 4 feet wide between. This received no dung; that cultivated in the common way produced

* A French bushel is to the English as $615\frac{368}{1000}$ to 2178, or equal to 1 peck, 1 quart, and 2 cubic inches.—An arpent is equal to 51691 English square feet, or to near one acre three quarters of a rood English Measure.

476 Sheaves, - or 2058 lb.	98 Bushels	98
Deduct feed - - 252	12	
1806	86	

Sheaves.		
The other 284 - 1470 lb.	70	70
Deduct feed - - 42	2	
1428	68	28

18 Difference.

He states the expence of dunging equal to 20. This brings that sown in rows at least to an equality.

But the value of an arpent in the common way cannot in three years be made more than equal to one crop of wheat, and the third of a crop. A crop of oats being reckoned equal to but one third of a crop of wheat; the produce in three years will be only $130\frac{2}{3}$ bushels, whereas that cultivated in the new way, will yield three crops of wheat, which supposing them equal to the first year's crop, will amount to 210 bushels. The seed sown in the common husbandry being 12 bushels, the increase is only $8\frac{1}{6}$; that in the new being 2 bushels, the increase is 35.

Mr. Duhamel states some experiments by Monsieur Rouffell, on ten arpents, in which he compared drilled crops after dung of different kinds* and quantities, with drilled crops not dunged. The dunged beds were distributed in such a manner that each of them was between two other beds, which were not dunged. The method of dunging was to open a large furrow in each of the alleys, which must be done every year at the end of the summer sowings, where the three rows of seed are afterwards to be sown. The space between two deep furrows is exactly the breadth of a cart, the wheels of which going in these, hurts no part of that which has been ploughed; and do not harden the loose mould; nor do the horses do any damage

as they tread upon the stubble. These beds were dunged in the above manner with horse-dung; three others with cow-dung, and three with sheep dung.—The best dung, he says, is that of sheep, and it is more profitable when laid under furrow, than when it is spread upon the surface of the ground, by folding.

Ten arpents in the new way, 3 beds, dunged with horse-dung.

1st. The first 184 toises long dunged with 3 load of horse-dung	-	-	-	-	-	-	19
1. The fellow to it not dunged	-	-	-	-	-	-	15
2. The second 185 toises dunged with $2\frac{1}{2}$ load	-	-	-	-	-	-	18
2. The fellow to it not dunged	-	-	-	-	-	-	14
3. The 3d 187 toises with 2 loads	-	-	-	-	-	-	16
The fellow to it not dunged	-	-	-	-	-	-	13

By this the dung produced 53, and that not dunged produced 42.

The others were nearly in the same proportions; the third with cow-dung, 45; not dunged, 35; that with sheep-dung, 46 to 31.

Ten arpents sown in the common way, after having been well folded all over, produced 1820 sheaves; and ten arpents in the new way produced 1208. On this Mr. Duhamel observes: "The 1208 sheaves produced but 240 bushels of grain, from which is to be deducted the seed $18\frac{1}{2}$ bushels; the produce is $221\frac{1}{2}$ bushels. This would make in three years $622\frac{1}{2}$. The other in the common way, produced 417 bushels; from which we are to deduct 60 for seed, the neat produce is 357; the half of which is $178\frac{1}{2}$ bushels for the next year's crop. The produce amounts to no more than $535\frac{1}{2}$; consequently the balance in favour of the new husbandry in three years is 129 bushels, or one fourth of the whole. These experiments shew the advantage of dunging in this manner.

Mr. de Chateau Vieux made a great many experiments, which shew the superior produce of the new husbandry.

husbandry. That gentleman gives a comparison of five drilled crops immediately following one another, with eight crops from the same field in sixteen years; the custom of the country being one crop and one year's rest alternately. He extracted it from a journal kept by his steward, who was scrupulously exact, even in the smallest concerns.

8 Broadcast crops, in 16 years	lb.	
produced - - -	11119	
Deduct siftings - -	1765	
Seed - - -	3558	
	<u>5323</u>	
Net produce of 8 crops in 16 years		5796
5 drilled crops in 5 years produced	8271 12	
Deduct seed, there being no siftings - - -	237 0	
Net produce of 5 crops in five years	<u>8034 12</u>	
The new husbandry produced in 5 years more than the old in 16 - - -	2238	$\frac{1}{2}$
5 drilled crops in 5 years produced net - -	8034 12	
5 broadcast crops in 10 years, the average per year being $724\frac{1}{2}$, produced - - -	3622 9	
The new husbandry produced in 5 years more than the old from the same number of crops in 10 years - - -	4412	3

Mr. de Chateau Vieux adds, that his fields, in beds, had not had any dung or other manure for many years.

As the increase of old husbandry in the above experiment is only at the rate of 3 after 1, farmers in England, who from better cultivation, soil, or climate, have a much greater return from a given quantity of seed, may think it unfair to compare the drill husbandry with the broadcast, when the increase of the latter is so small. But as the advantages or disadvantages of soil and climate are the same in both modes

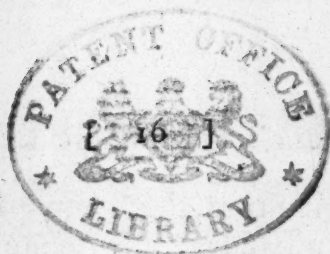
modes of culture, the proportion between them ought to be pretty much the same, where soil and climate are more favourable; and it is afterwards shewn, the drilled is more profitable in England, not only to 2 crops and a fallow, but to the improved broadcast of 4 crops.

Although the extensive improvers mentioned in this work did not find manure to be necessary for ground that had been some time in the drill hoeing husbandry, and properly horse hoed; it is certainly proper to use it, where the soil is poor: and when ground is first put into the new mode of culture. The full effects of tillage cannot be felt for the first year or two, and manure with tillage will bring ground into good order much sooner than tillage alone. The method adopted by Mr. Roussell seems very adviseable for persons beginning this mode of husbandry. It is proper also to guard against the accidents to which every new system is at first liable; if from inattention, or want of skill any of the operations of drilling, hoeing, &c. be neglected or imperfectly executed, manure will in some measure supply this defect of tillage. Last of all, it is proper to guard against the prejudices of the practical farmer, strongly prepossessed in favour of manure; thinking it hardly possible that a good crop can be obtained without it, if from an unfavourable season or bad management, his first or second drilled crop should fall short of his expectations, he immediately imputes to a radical defect in the system, what was only an accidental effect of the climate, or his own want of skill. If after a year or two, he finds that with manure, and proper horse-hoeing together, his crops are too luxuriant, he may then employ his manure on other lands that require it.

Those, who on the supposed authority of Mr. Tull have rejected the use of manure in the first instance, have occasioned the prejudice against the drill husbandry. It is also alledged, as an argument against
this

this mode of agriculture, that many persons who practise the drill husbandry, use manure also: a plain proof, it is said, that tillage does not answer alone.— But if manure gives such an increase of crop, as to repay the expence of it, and also that of laying it on, this does not prove that the drill husbandry does not answer, but that its good effects may be heightened by the use of manure. We have seen that Mr. Tull and others advise the use of this article, although they found it unnecessary, when they had brought their mode of culture to a certain degree of perfection.— Mr. Young's and Mr. Randall's experiments shew how little can be expected from it, where the ground is properly horse-hoed. But, were it of no use at all, the expence of it at first is well bestowed, to satisfy the mind of the broadcast farmer, that he is not to lose his crop for want of manure, till experience convince him that he can have crops without it.

Mr. Roussell's experiment shews the effect of manure on a first crop; but it does not prove that manure has much effect on land that has been some time in the drill culture, and is properly pulverized. To try the effect of manure on such land, part of an acre that had been two years successively drilled with wheat, was manured for the third crop, and some of the ridges were lined. The remainder was neither manured nor lined. At harvest the crop was so equal, that it was impossible to distinguish the parts that were dunged or lined, from that which was not.



CHAP. IV.

ADVANTAGES OF TILLAGE AND INCREASE OF PRODUCE.

TO pulverise the earth, it is evident must have its good consequences, for besides cleaning the ground, it makes it more susceptible of those nutritive qualities, furnished by the air to all vegetables, and this certainly is highly promoted by that free circulation produced by sowing in drills.

At the same time attention must be paid to the nature of the soil and climate: a thin light soil from its weakness must be less disturbed than land that is strong and heavy, and it will be necessary in the former to have the drills at a greater distance than in the latter, for reasons very obvious. As I have observed that manure was neither particularly recommended nor rejected, by Mr. Tull, I shall shew by well authenticated experiments, how far the want of dung may be supplied by tillage in general, whatever the soil may happen to be.

Mr. Tull, in his *Essays*, says “ I keep a team of horses for the use of a tile kiln, which helps me at present to dung for about ten acres yearly, but if I put them off as I intend, I shall not raise dung for above three acres, yet I propose to have six score acres of wheat every year, as I have at this time an hundred drilled on the stubble of last year’s wheat crop.”

Among a great many particulars of his crops he mentions “ a field, that was a kind of heath ground, that used to bring so poor crops that nobody cared to rent it. Dung and labour it was said, were
thrown

thrown away upon it. After two crops of oats had been taken from it, the last of which was scarce worth moving; it was put into hoeing culture, and when three hoed crops had been taken of turneps and potatoes, it was sown with barley, and produced a very good crop, much better than ever it was known to yield before. A good crop of hoed wheat succeeded the barley, and it was again sown with barley upon the stubble, and that crop also was better than the barley it used to produce.

"All the farmers," he adds, "in the neighbourhood said, that it is impossible but this must be very rich ground, because they have seen it produce six crops in six years without dung or fallow."

I shall mention only a few more instances of successive crops produced by the hoeing culture without manure. "In another field," he says, "there is the six crops of wheat in wide intervals, very promising, though this ground has had no sort of dung to any of these crops, or for several years before them. The last year's crop was the fifth, and was the best of the five, though a yard of the rows yielded but eighteen ounces and three quarters."

In another place he says, "As a yard of the treble rows of the third successive crop of wheat, without dung or fallow, produced 20 ounces of wheat, which allowing six foot to the ridge, is about six quarters to an acre; and allowing 7 inches for each partition, and two inches on each outside, is in all 18 inches of ground to each treble row, and but just the fourth part of the ridge. Now, if in the old husbandry, the crop was as good all over the ground as it was on these 18 inches of the treble rows, there must have been 24 quarters to an acre. But let them dung whilst they can, they will scarce raise 24 gallons of wheat the third year on an acre of equal goodness.

"But as the goodness of a crop consists in the
D quality

quality as well as the quantity, it is observed that drilled hoed wheat has larger ears and a fuller body than sown wheat. We can have more of it, because the same land will produce wheat every year. We do not pretend that we have always greater crops, or so great as some mention." Mr. Tull says, "The greatest produce I ever had from a single yard of length, of a double row, was 18 ounces; the partition of this being six inches, and the interval 36 inches, was, by computation, 10 quarters 80 bushels to an acre. I have often numbered 400 ears in a yard of my treble rows, but the greatest weight I ever had from a yard was the produce of 250 ears. I have numbered 109 grains in an ear of my wheat of the grey sort, and one ear of my Lammas wheat has been measured 8 inches long, which is double the length of the sown wheat. But there is no year wherein one ear of hoed does not weigh more than two of the sown ears, taking the whole sheaf together."

This calculation of Mr. Tull was upon ridges of 3 feet 6 inches. If ridges of 4 feet 8 inches produced the same per yard, as there are 2996 yards of double rows in ridges of this breadth, this would be 55 bushels per acre, exclusive of head ridges.

Again he says, "I have often weighed the produce of the same quantity of ground, and all sorts of wheat both the best and the worst; I allow two square yards of the crop to one yard of length of my drilled rows. I have never found any of the sown equal the best of my drilled."

Mr. Tull says "Mr. Houghton relates 80 ears from a single plant of wheat. But I have never found above 40 from a single plant in my fields; but I should not desire any to be so prolific, lest they should fail to bring such a multitude of ears to perfection.

"Some feed cane wheat coming out of the same heap planted at the same time, and on land of the

the same sort adjoining together, the wheat that was sown produced grain so small, and that which was drilled so large, that no farmer or buyer would believe them to be of the same sort of wheat, one grain of the drilled weighed two of the sown, and there was twice the chaff in an equal weight of the sown, being both weighed before and after the wheat was separated from the chaff.

“But though too great a number of plants be upon many accounts very injurious to the crops, yet it is best to have a competent number. We may expect a great crop from 20, 40, or 50 plants in a yard of treble rows.”

Mr. E. S. in *Museum Rusticum*, vol. iii. mentions his having found 77 grains per ear of $4\frac{1}{2}$ inches long, and that the ears are formed to produce above the amount if properly nourished.

To try what encrease wheat would produce, some wheat was planted in a garden, in drills, at three feet distance, (as mentioned in the 3d vol. of Bath papers) some with one grain at a foot distance in the row, and some at different distances; some with four holes per foot, into each of which was dropt seven grains, and others in different quantities.

Some of the single grains produced 52 ears per grain, with 42 grains per ear, 2184 after one. Those with 7 per hole, or 28 per foot, produced 100 ears per foot, with 39 grains per ear, or 139 after one, or 3900 grains per foot.—Another year one grain produced 29 ears with 56 grains per ear, or 1652 after one or per foot;—and 28 grains per foot produced 74 ears with 51 grains per ear, which is 134 grains after 1, or 3774 per foot:—and 4 grains per foot produced 72 ears, or 18 ears per grain, with 56 grains per ear, is 1008 after 1, or 4032 per foot. And the same experiments were tried a third time with much the same success. The greatest quantity of 23 grains per foot, has a space of $15\frac{1}{2}$ square inches per grain. This shews what great increase wheat is capable of producing af-

ter one, where it has space in rich soil; and what produce wheat will yield in good ground, which shews the mistake of those who suppose that two rows upon a ridge will not produce half a crop.

To see the increase and produce in the field, and from a greater or smaller quantity of seed, some wheat was dibbled in the field of a farmer in rows at 9 inches distant, and at 9 inches in the rows. Two rows were planted with grains per hole, and encreasing the number of grains per hole every 2 drills to 15. This was the 16th of an acre. These rows with 3 grains and 5 grains, appeared very bad until summer. The produce was at the rate of 26 bushels per acre. These rows where the most grains were planted, appeared much better and stronger plants in spring and summer; but did not appear to produce a number of ears in proportion to the seed: and on counting the ears of it, it was not found that there were more ears from the hole where there were 12 and 15 grains than in the place where a less quantity was planted. The 3d of November, one ridge (the 16th of an acre) was drilled with wheat by hand; the furrows were made with a hoe, and the seed dropped, and covered by hand. The quantity of seed sown was the quarter of a peck, or half a gallon, at the rate of 1 bushel per acre. The produce was 1 bushel 3 pecks, or, at the rate of 28 bushels per acre, or 28 bushels after one.

In the fifth volume of Bath Papers is mentioned—
 “ Half an acre was formed into ridges of 4, 8, including the two hollow furrows; upon this was drilled the 28th of October $2\frac{1}{2}$ pecks of red wheat at 12 inches distance in the partitions. It was five times horse-hoed, and twice hand-hoed in the rows. The partitions were hoed by a double horse-hoe. (See plate.) These were hooked on to an axle that was the length of the breadth of two ridges, with two wheels that went in the outer furrows, and the horse went in

in the furrow between the ridges, and drew the machine with shafts fixed to the axle; and the hoes were fixed to go on the top of the ridges in the partitions.

“ In the rows were a great many empty spaces of above a foot, from the faults of the drill, or other accidents, and the ridges being drilled where the furrows were last year—by this there was a single drill on the outside, most of which was destroyed by birds, who also destroyed a great deal of the wheat, it having a hedge along one side and one end. To see what might be the produce, was a field equally good and free from such defects, the ears of a yard of 4 double rows were counted at two places, at the top of the field, and two at the bottom, where they appeared pretty equal. Some single yards produced 130 ears per yard, some 128, some 115 and 113, and only one was below 100 ears per yard. The average of the double rows was 226 ears: if the ears produce 40 grains per ear, and allowing the grain to be very small, at 700 per ounce, (which is smaller than common wheat) this would be $12\frac{2}{5}$ ounces per yard of double rows, or nearly at the rate of 39 bushels per acre, had the whole been equally good, which could not be well expected. From being executed by another farmer's servants, not accustomed to drilling, and with a very bad and improper drill; when threshed, the produce was only 10 bushels 2 pecks, or at the rate of 21 bushels per acre, which shews the consequence of such faulty machines, bad execution and accidents.”

Some barley was planted in a field of a farmer upon a ridge the tenth of an acre, at 9 inches distant in the rows; some with one grain per hole, and encreasing the number of grain every two drills to 14 and 15 per hole.

Upon examining them in spring and summer, those drills with few grains per hole appeared very bad. As there were 12 rows or drills they increased in length of stems and colour, as the number of grain planted, the
first

first with one grain and few grains being the worst, and those with 14 or 15 the best.

The ears of one yard of each was counted when in ear, in 4 different places of the ridge.—Those with few grains, which appeared so bad in spring and summer, produced per hole at the rate of 20 ears per hole, and up to 8 grains of seed the same; and from that to 15, the average was about 24 ears per hole. The produce of this when threshed was 5 bushels $1\frac{3}{4}$ peck Winchester, or at the rate of 55 bushels 1 gallon per acre. Those with 8 grains per hole, or 32 per yard, have each a space of 10 square inches, and those with 15 per hole, or at the rate of 60 per yard, have a space of nearly $5\frac{1}{2}$ square inches.

From these few small experiments of drilling or planting in clusters or holes, it appears to confirm the opinion of thin sowing, from there being nearly as many ears per yard, as where double the quantity was planted in the field.

In the garden it is quite different, as although there was at 28 grains per foot, or 84 per yard of the rows, the space was so great, that each grain had a space of above 15 inches in so rich ground.

I have found many ears of broadcast with 40 grains per ear, but the average not above 20 per ear in rich ground.

Indeed every farmer must see, that when too much seed is sown the ears are smaller, and the plants weaker than where less seed is sown.

I shall state some instances of what has been actually received by the practisers of Mr. Tull's mode of husbandry, after the grain has been threshed out, and placed beyond all the accidents to which, until that time it is subject: although these are not so many as those to which the broadcast culture is liable.

Mr. Tull's crops on an average on 6 score acres, were 20 bushels of wheat of 9 gallons, which is 22 bushels 2 pecks Winchester measure; and on his
good

good land from 4 to 5 quarters, that is from 32 to 40 bushels, also of 9 gallons, which is 45 bushels Winchester. He says, "after 13 years experience of successive crops, the same 6 score acres that were in wheat last year, 12th crop, was the best I believe ever grown on it. It has now the 13th, and all of it is as strong, as in any former year, though there is only about 1 acre of it dunged.

"It is to such experiments that I leave the progress of my horse-hoed husbandry, assuring the public, that in all my practice I have never met one instance that gave me the least suspicion of the truth of the principles that I have advanced."

"Some," he adds, "object to my weighing a yard or perch in length, that this does not determine the produce of a field. They judge right, if the produce of the whole be not of equal goodness; if not, it must be because one perch is richer: for the same cause that produces 20 ounces per yard, must produce the same upon every other yard. We might weigh the poorest crop, to see how poor a crop we can raise.

"Another thing I have more particularly observed, that the more successive crops are planted in wide intervals, and often hoed, the better the ground does maintain them. The last crop is still the best, without dung, or changing the sort of plants.

"This is so visible, in parts of the same field, where some part having a first, some other part a second crop, the rest a third crop, growing all at the same time; which seems to prove, that the earth is made by this operation to distribute her wealth to plants, in proportion to the increase of her inner superficies; so the atmosphere, by the riches of rain and dews, does annually reimburse her, in proportion to the same superficies, with an overplus for interest. But if that superficies be not increased to a competent degree, and by frequent repetitions of hoeing kept increasing (which never happens in common husbandry) this
advan-

advantage is lost, and without repeated stercoration, (manuring) every year's crop grows worse."

He says, "*the different condition the land is left in after a crop by the one and the other husbandry, is no less considerable, than the different profit of the crop.* As a proof of this:— A piece of 11 acres of a poor, thin, chalky hill was sown with barley in the common manner, after a hoed crop of wheat, and produced full $5\frac{1}{2}$ quarters per acre, which was more than any land in the neighbourhood yielded that year, though some of it was so rich, that one acre of it was worth three of the thin chalky land: and no man can remember this land ever produced above half such a crop, even when the best common management has been bestowed upon it."

Another instance he mentions, "A field was drilled with barley after a hoed crop; and another on the same poor hill was drilled with barley: also, part of it a sown crop the same day with the other: there was no difference of the soil. The former of these had no manner of compost on it for many years before; yet its crop was not near so good, as that which followed the hoed crop, though the latter had twice the ploughing before drilling, and the same hoeings after.

He says, "I could give many instances of the same kind, where hoed crops and sown crops have succeeded better after hoed crops than sown crops; and yet have never seen the contrary, and therefore am convinced that the hoeing (if it be duly performed) enriches the soil more than dung, and fallows and leaves the land in a much better condition for a succeeding crop. The reason I take to be obvious: the artificial pasture of plants is made and increased by pulverizing only; and there is nothing else in our power to enrich the ground, but to pulverize it, and keep it from being exhausted by vegetables.

Sir Digby Legard mentions comparisons which he made of drilling barley on 5 acres. This land had
borne

borne four successive crops; 1 barley, 2 wheat, and 1 turnips. The land had been horse-hoed every year, but had never any manure, except that the turnips had been eaten off by sheep. In April 1763, half an acre was sown by hand, and took five pecks of seed; half an acre drilled equally distant rows, one foot asunder, took 3 pecks of seed. Two acres were drilled on ridges, five feet broad, in double rows, 11 inches asunder, and took 6 pecks; 2 others on 5 ridges in treble rows, and took 4 pecks. The 4 acres drilled were horse-hoed 3 times: the produce was,

	Q. B. P.		
In the old way, at the rate per acre	5	4	2
Equal distant rows, per acre - - -	6	0	2
Drilled, and horse-hoed do. do. -	3	0	11

The advantage appears to be on the side of the old husbandry, as it is double of what is cultivated in the new way: but the greatest is that sown in equally distant rows. On the other hand, although 6 quarters is a very great fertility, it was in a considerable degree owing to the excellent culture bestowed on it by the horse-hoeing, during the four preceding years crops, which were none of them bad. So far were these from having exhausted the earth, that the four drilled acres were afterwards drilled with wheat at once ploughing.

In April 1764, 2 acres were drilled with barley, on ridges, 4 feet 6 inches broad; 2 rows at 10 inches on the top of the ridges, and took 2 bushels 2 pecks of seed. One acre adjoining was on the same day drilled with barley, in equally distant rows, 1 foot asunder, and took 2 bushels of seed. Another acre contiguous, was at the same time sown in the broadcast way, and took 2 bushels of seed; 2 ploughings had been given to it: after a crop of oats, the horse-hoeing part had 3 hoeings, and was once hand-hoed, the other could not, as it was sown with grass.

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The

	Q.	B.	P.
The $2\frac{1}{2}$ acres horse-hoed, produced	10	5	0
The one equal distant - - - -	4	4	0
The one sown broadcast - - - -	4	2	0

In 1765 the $2\frac{1}{2}$ acres horse-hoed the preceding year, were again drilled with barley, and managed as in the former year.

	Q.	B.	P.
The produce was - - - -	10	0	0

Sir Digby mentions the mediums for 3 years of the horse-hoeing to have been 3 quarters 6 bushels, and with this he compares the Norfolk course.

In another letter he says, "The same field in which the experiments of barley were made, as related in 1763, is now sown with wheat. The 8 successive crops of this field were wheat; yet the land is so far from being exhausted by so many burdens, that it seems yet in perfect heart, though no manure has ever yet been laid upon it.

Mr. Crack, near Dumfries, who practised the drill husbandry, says in his letters, "About 7 years ago I began to drill in double rows, on ridges 5 feet broad, but I have now reduced them to 4 feet 10 inches. I continue the double rows of wheat, and drill a little short of a Winchester bushel to a Scotch acre, ($1\frac{1}{4}$ English.) My return, upon an average; is about 25 of the said bushels since I began. The total expence of harvest home is about a guinea, seed included; but my return would exceed this, were it not that some parts every year failed, which failure was occasioned by a vein of sandy gravelly soil that runs across two of my fields.

I have now the 7th crop growing on my first acre. This acre, as well as all my fields, was dressed at first with shells, and bore 4 broadcast crops immediately preceding the drilled crops.

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The field with the 6th drilled crop, and which had 5 broadcast crops previous to these, has as full a crop as can stand upon it, except where the sandy vein comes in.

In general, where the soil was originally tolerable, I cannot perceive any decline of the crops. Last year, on half a Scotch acre, I had 22 Winchester bushels; (35 bushels per English acre,) but these lands were all equally good soil: but the return would considerably exceed this, were it not for some parts of every field, that have every year failed; in some, as already mentioned, by a vein of sandy gravelly soil that runs across two fields, and in all the others, from levelling old crooked ridges.

I have now the 7th crop of drilled wheat growing on my first acre;—and at present, it promises to be the best. This acre consists of 22 ridges, 9 of which were 3 years ago strongly manured with dung: that side being lighter, generally failed since dressing, that part has proved better, but is still inferior to the undung side. The field with the 6th crop of drilled wheat, and which had 5 broadcast crops previous to this, has as full a crop as can stand upon it, except where the sandy vein comes in. The field with the 5th crop is inferior to it, though as good a soil.

The Rev. Mr. Dean, a clergyman in Berkshire, who practised horse-hoeing, in a letter written several years ago says, "In my opinion Mr. Tull's principles are founded on truth. I have practised his horse-hoeing husbandry above 20 years on the same land, with successive crops of wheat, and can see no reason to question the truth of his principles.

"Mr. Tull used all the manure he had of his own as I do. A part of a field near my house has tasted no dung or manure since I began. For experiment sake the other part was frequently dunged, and the whole cultivated alike: But the difference of the crops at harvest was scarce discernible. My servants,

who knew the place, thought they could perceive the odds: but it would be very difficult for a stranger to find it out. In general, my Tullian crops (which are large and upon various fields) have been nearly equal to the sown crops of my neighbours in the different years." His drills were the same as those described by Mr. Tull, which sow only two rows for horse-hoeing.

Mr. Dean tells us that he practised Mr. Tull's horse-hoeing husbandry above 20 years on the land with successive crops of wheat, with but few intermissions. He says, "Through the frequent avocations of my servants, and neglects in catching critical seasons for horse-hoeing, my lands became foul and out of tillage. This was the reason of intermitting my annual crops to clear the land, which has happened about three times since I began.

"I can only say in general, that my Tullian crops have been nearly equal to the sown crops of my neighbours. I plant 3 pecks of wheat on a statute acre, and receive from 2 to 4 quarters in return. The farmers in the old way plant about 10 or 12 pecks on an acre, and receive in return no more than I do.

"This last year, (the wettest I ever remember; therefore the most improper for pulverizing the soil,) afforded me 22 nine-gallon bushels of clean corn, ($24\frac{1}{2}$ bushels Winchester) from a statute acre. My soil is not the best wheat land, nor adapted for Tullian husbandry, because we suffer greatly by the extremes of both wet and dry seasons, sometimes our land being bound up as hard as iron, not to be touched with a plough, and sometimes all in a pap, not to be trod upon."

Mr. Philip Millar, author of the *Gardener's Dictionary*, mentions two experiments of the drill husbandry compared with the broadcast: "First, a field was sown, partly with broadcast, and partly in Mr. Tull's method with wheat. The drilled was sown at
2 feet

2 feet distance, and stood then in the rows ; the roots formed by these grains of wheat, had from 10 to 30 stalks, which continued upright till the corn was reaped, whereas few of the roots of the common husbandry had more than 2 or 3 stalks, and most of it was lodged before harvest. When threshed, there was near a third more in weight and measure from the drilled, than from the same extent of ground taken in the best part of the field sown in the common method."

The second experiment was sowing the corn at different distances : of some sown in two parts of the field, that which was sown broadcast was lodged, as was most of that where the rows were *six* and *nine* inches asunder. That which stood at *one foot* escaped better, but the rows at *two feet asunder* were the best, and produced much more than any of the other ; this shews the absurdity of a great quantity of seed, in order to have a greater produce, which is the opinion of most farmers.

" I have been informed by persons of great credit, that on good land, which was drilled and managed with the horse-hoe, they have had 12 quarters from an acre of land, which is a great produce ; and this with greater certainty, if the season prove bad, than can be expected by the common husbandry."

Mr. Randall, author of the semi-Virgilian husbandry, practised drilling in all the different manners, and to a great extent ; he is of opinion, that dunging ground made fine by tillage and ploughing, does hurt and lessens the crop. In giving directions for his method of culture, which he calls *limited* or *garden* Fineness, he says, when ground is one fourth short of this degree of fineness, dung adds one fourth, but because in the general practice, the weeds are carried into the ground with the dung, they rob the ground of one fourth part. If the fourth wanting be added by tillage, it brings the soil to garden fineness, and

and produces a crop of 48 bushels, whereas if added by dung, it produces only 36.

And again, he says, "Here the reader is to take notice, that if a favourable season happen, and all things are done as directed, applying the dunghill will ruin the crop, if it serve him as it served me."

Another proof of manure not being necessary, or of much advantage to the crop when drilled and hoed, as it comes from a gentleman, who is no favourer of the drilled husbandry, will have the more weight with those, who suppose that tolerable crops cannot be obtained in that husbandry without manure.

Mr. Young, in his *Experimental Agriculture*, among many experiments mentions one, comparing the broadcast and drilled modes of agriculture after fallow, as well as in successive crops.

In the drilled husbandry,		PER ACRE.		
		Q.	B.	P.
5 crops drilled and manured		3	1	0
8 drilled after fallow, equal distant rows		3	7	2
8 drilled after fallow, and horse-hoed		3	1	3
The average of the fallowed		3	4	0
10 successive	- - - -	2	1	0
31	Average of 31 crops	-	3	0 0

He says, "Hence it appears, that manuring the drilled crops by no means answers. The produce of the manured crops is only one bushel superior to the average, a superiority so trifling, that it does not prove even the benefit of the manure: when the expence of the manure is thrown out of the accounts, the profit arises to 1l. 11s. 6d. but when included amounts only to 11s."

In the third volume of Bath papers, is an instance of the successive crops without manure, by Mr. John Butt, of Kingston; beans were planted in drills near 2 feet apart, in a good clay soil, after 2 ploughings, and being horse-hoed 3 times, the turnips being sown in

in the intervals after the third hoeing. There was no kind of manure or dressing laid on the ground for six crops past, nor is there any need of it, as I find by experience, that drilling and horse-hoeing answer the end.

The crop of beans was near three quarters per acre.—The weight of the turnips was 37 tons and 5 pounds, as measured by Mr. Pairour and Mr. Headford.

Mr. Pairour, in a letter also gives an account of this crop: "I was informed that the field which contains little more than 6 acres has been under a course of drilled husbandry for 5 or 6 successive years, during which it has had no manure or top dressing. The beans were drilled the last spring at less than 2 feet, they were horse-hoed 3 times. At the 3d hoeing the turnips were sown promiscuously amongst them about Midsummer."

In the 4th volume of Bath Papers, Mr. Hazard gives the following account: "A field was cultivated upwards of 12 years, and had every year uncommonly large crops.

"The first was peas; they were sown in drills 2 feet 8 inches apart, which were twice hoed, and afterwards earthed; they were gathered and sent to market, the straw cut and given to horses, the ground cleared the 13th July.

2. "The ground was immediately cleared and sown with turnips broadcast, which were twice hoed. The field sold for 5l. per acre, and cleared the beginning of February.

3. "Was ploughed and afterwards well pulverized, it was sown with spring wheat *broadcast*, was never hoed nor weeded.

4. "In autumn the 2d year, the ground was ploughed without delay, and spinnage sown in 4 feet drills. This stood the winter; and midway between these drills garden beans were planted the following January.

January. Both crops were hoed; the spinnage was cleared by the middle of May.

"The ground received another hoeing, and on the same drills where the spinnage grew, cabbages that had been raised in a seed plot were planted. The beans stood for seed, and were sold for 8s. a bushel; the cabbages were carried from the land, and given to cows in February.

"It was ploughed after the cabbages were removed; and after the ground was well pulverized, peas were sown in drills 3 feet asunder; these were gathered and sent to market.

"And after the autumn these were removed, and coleworts, which had been in a seed plot, were planted about 12 inches distant from each other. This was a good crop, and sold to cow-keepers."

Thus were *eight* profitable crops obtained in 4 years. The writer of this says, he was eye-witness to the crops which were raised upon the same land, the 8 succeeding years, and knew them to excel all in the neighbourhood.

The mode of cultivation was nearly the same in all, except that barley was sown on the 4th year, instead of spring wheat. Oats were sown in like manner, and potatoes were once planted between drills of seed beans; and the hoeing was always attended to, and well performed, except when the land was sown with corn.

"It has been lately laid down with grass, and is come to a good sward without having any *manure* laid upon it for more than *sixteen years*; 12 of which it was cultivated as before related.

To try the effect of drilling ground in bad order, and what crops it would produce, the writer of these remarks drilled 1 acre that was in very bad order, for 4 years successively, with wheat upon ridges, 4 feet 6 inches, with 2 rows at 10 inches, and without any manure, and reaped and threshed the eightieth part,
or

or 37 yards 1 foot 4 inches. From this it appeared that an acre produced at the rate of from 24 to 28 bushels per acre, without declining, the last being the best.

The author of the scheme of drill husbandry states the produce of 8 successive crops upon the same land without manure; the produce of the 4 last crops of wheat increased every year, the last crop producing 29 bushels. All these drilled crops yielded greater crops than the broadcast with manure.

In the Bath Society Papers, vol. 2, is mentioned an experiment for one year of drilling wheat horse-hoed, upon a light soil in bad order. It was manured with a compost dunghill of earth and dung; the produce was 28 bushels 3 pecks. Another instance is given in the Bath Papers of manuring drilled crops, by a very intelligent farmer, Mr. Anderson, who practised drilling for 11 years successively, during which time he manured twice, the first year with 12 hogheads of lime per acre, and 8 cart loads of dung.

For the 6th year he again manured with 20 hogheads of lime per acre, mixed with the earth and the rubbish of an old lime-kiln, at the expence of 1l. 19s. per acre: at another time, laying about 20 cart loads of earth and rubbish on a small portion of the field, where the natural soil was remarkably thin: the whole expence of manure for 11 years amounted to near 5s. 4d. per acre per annum. The ground is from 5 to 12s. per acre; he drilled 2 rows upon 5 feet ridges: his crops were from 19 bushels to 9 per acre.

The average of the 11 crops was 14 bushels. When the crop was only 9 bushels per acre, it happened from over-steeping the seed, and a very wet season following, the crops of wheat in the same parish, taking the good ground with the bad, and some run to 1l. an acre, for the 11 years, I have been well informed, were on an average not more than 15 bushels an acre. By the drill mode there is a saving in

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feed

seed of one bushel or more per acre, with the advantage of a crop of wheat every year. Mr. Anderson mentions having horse-hoed, sometimes, only twice, which he says should be repeated at least four times: this he thinks necessary to that mode of husbandry.

In Mr. Duhamell's Husbandry, translated by Mr. Mills, are a great many valuable experiments on this husbandry, to which I must refer the curious, as too long to be here stated; and as they are in different measures, both of grain and land, which would embarrass the farmer.

But he clearly proves, by many experiments, that Mr. Tull's system of drilling and horse-hoeing was, without any manure, much superior to the old broadcast; and also, that repeated successive crops of wheat were to be obtained, of which he gives many instances for five and six years.

He made also many comparisons between horse-hoed crops with 3 rows upon 6 feet ridges, and equally distant rows, or 6 upon 6 feet ridges; and shews the horse-hoed was superior to the equally distant rows; but the last always preferable to the common way of sowing. He had not seen Mr. Tull's latter publication, where he gives the preference to 2 rows upon ridges of 4 feet $8\frac{1}{4}$ inches broad.

These examples are not on small trifling scales of a pole or a rood, but on whole farms; and he gives not only those of Monsieur De Chateau Vieux as well as his own experience, but that of a great many people of rank and fashion, as well as common farmers, and in different places of France as well as at Geneva.

Dr. Hunter, in his Georgical Essays, shews the advantage of drilling, and mentions some experiments of drilling turnips and barley. In one of turnips he says, "At the time of sowing, the land was extremely dry, which induced me to make the experiment with the drill plough, knowing that I could put the seed into
into

into the moister part of the soil, and that in the driest seasons, at the depth of two inches, we are sure to find a sufficiency of moisture to make the seeds germinate.

“ In spring 1769, I sowed an acre of barley on equal distant rows with the drill plough, in a field that was sown with the same grain, and upon the same day, broadcast. The broadcast took 3 bushels per acre, the drilled required only 4 pecks; the drills were at 8 inches, and the seed was lodged about 2 inches within the soil.

“ Reflecting on the experiments of the roots of wheat, I dug up some of the roots of the drilled and broadcast barley, and was most agreeably surprized to find the cause of difference to be in the roots. The pipe of communication between the seminal and coronal root of the drilled barley, was considerably longer than of the broadcast, and upon that appearance, I was convinced that the length of the ear, and the strength of the straw principally depended. The produce of 200 square yards of the broadcast and drilled barley was threshed; the drilled exceeded the other nearly one fifth in measure, and being better grain, weighed heavier at the rate of 2lb. per bushel. When the ears were formed, the ear of the drilled barley was plainly distinguished to be near half an inch longer than the broadcast.”

“ From the experience I have had of the drill sowing I can recommend it as a most rational and judicious practice. Proper instruments are wanted to come cheap to the farmer, and to have the requisites of strength and simplicity. Should we ever be so happy as to see this difficulty removed, it is probable that all kinds of grain will be cultivated in drills: it will be needless to observe, that in this essay I only recommend the drill plough “ for sowing the land in equal distant rows, instead of distributing the seed by hand. The drill, when connected with the horse-hoe, con-

stitutes quite a different system, which has great merit when judiciously conducted."

Mr. Young, on viewing Mr. Legrand's farm says, "He has the finest crops of furrowed barley I have seen in Kent; it will not be less than 7 or 8 quarters per acre. Last year he furrowed in barley on a clover lay, 2 acres and 28 perches produced 22 quarters 3 bushels; as in Mr. Legrand's letter, two years after, in vol. 4, of the Annals, he says, the 12 acres of sprat barley you saw in my fields produced 103 quarters 4 bushels Winchester, 8 quarters 5 bushels per acre."

The field is now in barley again, and to all appearance the crop is equally good.

A gardener drilled a piece of ground with wheat in November, in 1783; it was 100 square yards, it had been potatoes in 1782; it was dug with a spade, he made a small track or furrow with a hand-hoe, and sowed the wheat by hand, and covered it with the hand-hoe. The seed was nearly the eighth part of a peck, the rows were at 14 inches distance. In March it was hand-hoed, and a second time as soon as the weeds appeared, and the rows were weeded by hand, in the beginning of July, and a second time about the end of August, when in the shoot blade, and when the ear grew heavy, it was laid much, but not quite laid down: the ears were remarkably long, some from 6 to 7 inches; the produce was 2 bushels, which is 64 after one: the seed one eighth of a peck per 100 yards, is at the rate of nearly 6 pecks per acre, 1 bushel 2 pecks; and the produce at the rate of 96 bushels per acre. The crop was greatly too thick on the field.

An experiment of drilling was made in 1776, upon 1 acre 3 roods 20 perches; this, which was oats last crop, was ploughed in October 1776, for wheat, and drilled after once ploughing. The drilled, at 13 inches, cros the way it was ploughed: the drill was a hand-drill, which drilled one row; the seed was 6 pecks
of

of red wheat; it was hand-hoed in March, and twice hoed in May and June with a hand-hoe: the produce was 73 bushels. Many of the plants were killed in the winter, which were replaced by transplanting, and the transplanted roots produced more ears than those originally sown. In 1777 this field was again drilled for crop 1778: it was ploughed once cross the drill, and harrowed and drilled across the furrow, which made the rows the same way as last year: it was drilled with a drill-barrow or hand-drill, with 2 bushels of wheat, the drills at 11 inches distance; it was twice hand-hoed in the rows, and once hoed with a species of hand-schim. The produce was 63 bushels in 1778.

This was again drilled as before; one half of it was sown with grass seed immediately after the second hoeing, and was harrowed to cover them; and this half was hoed with the hand-schim: the seed and produce were the same as the preceding year. In 1780 the one half was grass, the other half was drilled with barley: this half was 3 times ploughed after the wheat, and drilled with 3 bushels of barley, the drills at 11 inches; it was twice hand-hoed, and once with the schim: this half produced 48 bushels of barley, crop 81; this half was once ploughed after the barley, and drilled with 3 bushels of oats, the drills at 11 inches: it was twice hand-hoed, and once with the schim. In 1782 ploughed up the grass and oat stubble once, and drilled both across the furrows; the drill 11 inches distant, with 1 bushel and 2 pecks of wheat; it was twice hand-hoed, and once with the schim: the produce was 47 bushels of wheat. In the year 1783, the one half was grass, sown with last crop of wheat, the other was potatoes planted after the plough, and where the ground was the poorest it had a little dung.

This experiment, continued for so many years, shews the great benefit of hoeing; as in six years it produced

produced four crops of wheat; three of these were successive, and in that time 246 bushels one year barley, besides half an acre of oats.

The expence of hoeing which is less than common hoeing: it was upon a pole, like a Dutch hoe upon a wheel, which a man pushed before him, and which he could walk much faster with than a common hoe.—The man who made this experiment was a ploughwright, who made the drill and hoe for a person who tried experiments of drilling.

In the 5th volume of the *Annals of Agriculture*, Dr. Hinton made a comparison between wheat sown by Mr. Cooke's machine and by hand. Quantities of seed used per acre were, by the machine, 1 bushel 4 quarts, one half pint: by hand, 1 bushel, 29 quarts, or $7\frac{1}{4}$ gallons. The machine sown was twice hoed by the machine; cost in the whole 4s. per acre, besides rent.

The weeding the hand-sown cost 6s. 10d. per acre.

The machine-sown produce per acre, 44 bushels, 2 quarts.

The hand-sown, 38 bushels, 18 quarts.

The weight of the former, 62lb. 2 oz. per bushel.

The latter 61lb.

In the *Farmer's Tour* through the East of England, the author mentions a great variety of experiments of drilling all kinds of grain; wheat, barley, oats, beans, peas, and turnips; and says, in that journey he passed through a part of Kent, in which drilling most crops was common. He mentions above 30 crops, of which he gives the particulars. The average of the wheat drilled, is 25 bushels at different distances, from 8 inches to 2 rows on 5 feet ridges. The average of the broadcast was 24 bushels. He states a comparison some of those gentlemen made between the drilled and broadcast culture, and on the average of all the grain, the drilled is superior. He says the real truth is, "that drilling and horse-hoeing on the Kent-
ish

ish system, of close drilling, are most advantageous; but the broadcast much exceeds the Tullian system of wide intervals. The method pursued in Kent, with respect to peas and beans, seems to deserve universal imitation.

“ The same observation is undoubtedly to be made with respect to barley and oats on light loam, and dry enough always to be ploughed on the flat. The success there with this husbandry is so great, that no unfavourable conclusion can possibly be allowed.— Close drilling on dry soils is very beneficial, since the Kentish farmers have invented horse-hoeing schims that work in 9 inches.”

From the few experiments mentioned of horse-hoeing, it is apprehended that of the Rev. Mr. Dean, and Mr. Butts’s comparison, with equidistant, shews the horse-hoed to be more profitable.

ASCERTAINMENTS OF CROPS.

In 1786 Mr. Boot announces a clear profit over and above his usual profits of 500l. by drilling 368 acres is 11. 7s. 2d. superior profit.

In 1787, he announces a clear profit of 700l. over and above his usual profit; the produce of eleven different experiments, as follows, on 450 acres, is

						PER ACRE.	
						B.	G.
Beans	-	-	-	-	-	50	0
Wheat after beans	-	-	-	-	-	36	0
Wheat after beans	-	-	-	-	-	50	6
Barley after turnips	-	-	-	-	-	75	5
Barley upon sandy land	-	-	-	-	-	58	4
Peas after clover	-	-	-	-	-	51	4
Wheat after beans	-	-	-	-	-	45	5
						Oats	

					PER ACRE.	
					B.	G.
Oats after barley	-	-	-	-	75	3
Oats upon loamy soil	-	-	-	-	76	6
Wheat upon poor cold clay	-	-	-	-	25	4
Wheat sown broadcast	-	-	-	-		

He mentions experiments by Sir William Jones.

					DRILL.		
					B.	G.	P.
Wheat by the machine	-	-	-	-	25	1	20
Wheat by the drill	-	-	-	-	27	2	25
Barley by the machine after wheat	-	-	-	-	27	0	22

Twenty-four others mention their approbation of the drill husbandry. One gentleman, whose estate is 700 acres, has it now all under the drill.

Some say that the drilled is 4 bushels more than the broadcast. Some say it is 20s. in favour of the drilled compared with the broadcast; all the others allow the drill to be superior, and most of them have given over the broadcast.

Mr. Boot observes, respecting the following comparison, made in 1788, that towards the latter end of April, when the four acres drilled gained a decided superiority over the adjoining four acres broadcast, which was self-evident by the strength of the plants, and being of a darker green, he determined to give the broadcast every advantage; and accordingly had it as well hoed as was practicable to be done, which evidently improved the broadcast crop, in which, if the weeds had been suffered to grow, the four acres drilled would have exceeded the four acres broadcast more than one third. He also remarks, that hoeing cannot be performed so effectually in a broadcast crop as in a drilled one, but that after all the care that can be taken, many weeds will be left growing.

For

For this comparison between 4 acres upon cold clay of drilled wheat, and 4 acres of broadcast, which was laid before the Society of Arts, Mr. Boot received a gold medal.

	PER ACRE.			FOUR ACRES.		
	B.	G.	P.	B.	G.	P.
The produce of the drilled was	29	6	3	119	1	4
Of the broadcast	23	4	5	94	2	4
Drilled superior -	6	1	6	24	7	0
Which is at 5s. 6d. per bushel,	-	-	-	6	16	9 $\frac{1}{4}$
With 6 bushels sowed of seed, which cost 7s. 4 $\frac{1}{2}$ d.	-	-	-	2	4	3
Extra expences of drilling 4 acres at 6d. and } extra hoeing at 1s. 6d. - - - }	-	-	-	9	1	0 $\frac{3}{4}$
At 2l. 3s. 3d. per acre superior profit - -	-	-	-	8	13	0 $\frac{3}{4}$

He states the produce of his crops upon 323 acres, as follows: the quantity of each.—Wheat, 70; barley, 90; oats, 7; beans, 52; peas, 28; turnips, 70; coal, 6 acres: in all 323 acres. He says he had not ascertained the quality as well as the quantity; but was informed by his neighbour, that last year the grain of his drilled crops was superior in quality two pounds weight per bushel.

Mr. Boot states the produce of his crops.

	B.	G.	P.
1 Beans after barley, per acre - - -	42	1	0
2 Ditto - - - - -	38	0	3
3 Barley after turnips - - - - -	61	5	0
4 Ditto after peas - - - - -	52	5	4
5 Ditto, ditto - - - - -	66	4	5
6 Ditto, ditto - - - - -	62	6	5
7 Beans upon mixed foil - - - - -	44	2	0
8 Peas after wheat - - - - -	31	6	1
G 9 Peas			

				B.	G.	P.
9	Peas after wheat	-	-	42	2	3
10	Wheat after clover	-	-	29	4	4
12	Ditto, ditto fallow	-	-	31	2	2
12	Ditto after clover	-	-	41	2	2
13	Oats after turnips	-	-	62	1	3
14	Wheat after turnips	} The comparison mentioned of 4 acres.	} Drilled	26	6	3
15	Do. do.			23	4	5

Many other instances could be given of the superior produce of the drilled crops above broadcast.—

“In the 12th volume of the *Annals of Agriculture*, is mentioned one, where the drilling equally distant rows is found superior, without the assistance of hoeing. Two acres were sowed, (part of a field) with 3 bushels of wheat per acre. The exact half was measured and drilled by Mr. Horne’s 5-furrow drill, with rather less than 2 bushels per acre. The drilled part produced 3 bushels per acre more than the broadcast, and one bushel of seed was saved; this was not hoed. The advantage of this arose solely from the regular distribution of the seed, and being placed at a proper and equal depth.”

In the *Annals of Agriculture* are a great many instances of the superiority of the produce of this method above the broadcast; some 4 bushels per acre, some 8.

An instance is given of the saving of seed by using a five-furrow sowing machine for two seasons, on 350 acres of wheat, barley, oats, and saint-foin: the saving in seed was 78l. 5s. 6d. and many of the crops were much better than they otherwise would have been.

These instances, from the extensive practice of the drill husbandry, as well as from trials on a small scale, are from such authorities, that they cannot be controverted. Arguments will not contradict facts; neither will small or unsuccessful experiments prove that Mr. Tull, Mr. Crack, and the Rev. Mr. Deane, had

had not such crops as they mention ; and a stronger instance than Mr. Dean's cannot be, that proved successful above twenty years. Small experiments and calculations from them, however accurate, although they shew what may be produced, are by no means to be depended upon, that such will be the produce of a field, or even an acre. I have frequently had a proportion of a field of broadcast, as well as a proportion of drilled, reaped and threshed, but never found the calculation correspond to the real produce. Several calculations are here stated from actual experiments, to shew what very great increase grain will produce ; but I shall by no means desire any one to rely on a field producing at that rate, from calculations of small experiments ; extensive practice is most to be depended upon.

The practice and experience of the method of close drilling, for several years past, has clearly demonstrated that a much smaller quantity of seed sown in drills, produces a much greater crop upon an acre than the broadcast, and that allowing more space increases the produce.

Drilling beans, and hoeing them, has been the practice for near 100 years, and experience has shewn, that drilling them at 18 inches, and horse-hoeing them, is much superior to narrower spaces hand-hoed. It is surprising that it has not occurred, that the effects must be the same with other grain, and that those who found the effect of wide intervals, and deep hoeing upon beans and potatoes, have not been induced to try the same method with other grain : having had such examples as Mr. Tull and his followers. The want of drills was long an obstacle which is now removed, and these drills have shewn that drilling and *hoeing* other crops, is equally advantageous as drilling and *hoeing* beans.

As we see so large crops stated by Mr. Tull in the horse-hoeing, and in the equally distant rows, crops

so great as to produce 50 bushels per acre, or after one, we may expect an equal produce after one, or 50 in the horse-hoed. As 3 pecks being sown is $37\frac{1}{2}$ bushels per acre, and upon ridges 4 feet 8 inches is 12 ounces per yard of double rows: and as Mr. Tull stated his greatest produce from 250 ears per yard, this is one third less, or $166\frac{1}{2}$ ears.

However incredulous farmers were some time ago, of the success of Mr. Tull's husbandry, (even some intelligent farmers who had tried it) yet the present practice of equally distant rows, at 9 inches, which is practised to great extent, has shewn his first practice to be right, and his principles just.

Those farmers who follow this practice, have copied his first but not his last method, which he found the best, and recommends it as such, after thirty-nine years experience, and the last thirteen were successive ones, and eighteen years of horse-hoed crops.

Mr. Tull, and those gentlemen who followed his method, were gentlemen of credit and veracity, who may be depended upon: therefore the practical farmers may, with more confidence, follow his last method of horse-hoeing than his first; the more so, that they see the proof of the first method of equal distant rows, from the late practice, of which they were equally incredulous; and from the improvements in drills, the hoeing husbandry has prevailed over prejudice so much, that of one construction of drills, there has been above 600 fold within these few years, and above 100 of them the last year, and mostly to practical farmers: which is a strong proof of their advantage, as practical farmers are so much convinced of the advantage of drilling, as to get the better of prejudice, and purchase an expensive machine.—That the success will not be equal on all ground of either equi-distant rows, or horse-hoed, every farmer knows; and if the ground is bad, and not properly cultivated, it is not to be expected to be equal to good land.

Though

Though I know it is difficult to break in upon habit, or alter custom; yet I hope these experiments and arguments will meet with a candid reception, and induce some to make a fair trial; for it plainly appears that this mode is by no means difficult, the produce greater, the expence less, than what can be effected by any other system.

For the convenience of the Reader I shall subjoin a compendious view of the experiments mentioned.

Successive Crops mentioned in this Work.

Page	Crops.
16	6 Mr. Tull mentions 6 crops without manure, ground in bad order.
17	5 Ditto, 5 crops,
24	5 Sir Digby Legard's comparison of drilling 5 acres.
26	8 Ditto, 8 crops on 5 acres.
	8 Ditto, a comparison with 7 acres.
26	7 Mr. Crack, near Dumfries, had seven successive crops.
27	20 The Rev. Mr. Dean practised this husbandry above 20 years without manure, with about three interruptions by the neglect of servants.
30	6 Mr. Bult of Kingston, on clay soil.
31	12 Mr. Hazard mentions 12 years successive crops without manure, and in four of these years it produced 8 crops.
32	4 The writer of these Remarks tried four successive crops of wheat without manure or declining.

Page

- 33 8 The Author of the scheme for drilling
 had 8 successive crops, and the
 produce of the four last, which
 were wheat.
- 33 11 Mr. Anderdon mentions 11 crops,
 during which time it was ma-
 nured twice.
- 37 8 An experiment of drilling equal-distant
 rows at 13 inches, 4 wheat, 2 oats,
 2 grafs and potatoes.
- 23 13 Mr. Tull had 13 successive crops of
 wheat without manure.

STATE OF HORSE-HOED CROPS.

	Bush.	Pecks
Mr. Tull mentions the produce of only one; per acre . . . }	29	0
Mr. Crack states 7, at average . .	25	0
The Rev. Mr. Dean, who drilled about 24 years, states only one, the worst he remembered for pul- verizing, produced . . . }	24	3
The Author of the Scheme of drill- ing, 4 crops, one 28, one 29 per acre; average . . . }	25	1
Late experiments 5; average .	26	2



DRILLING.

THE method of drilling or planting grain had been attempted many years ago (as afterwards mentioned); but Mr. Tull's method was treated with ridicule, as it differed so much from the common practice and prepossession of farmers, that for many years none attempted to make experiments of it.

Some writers at the same time wrote against his method, and many false stories were propagated against it. A great part of his notes are answers to these.

His Essays upon his method of drilling, with the descriptions of his drills and hoe-ploughs, are contained in two hundred pages of large print in folio, published 1733; and the Supplement and notes published 1736, are fifty-nine folio pages of a very small print, which consist of explanations and answers mostly to those, who wrote against his system, whom he calls the *EQUIVOCAL SOCIETY*; and in contradicting the falsehoods and many reports propagated against his husbandry.

His Addenda to horse-hoeing appears to have been published about 1738, (as he mentions the crop received in 1737 of 100 acres drilled) consisting of eleven pages of additions and explanations to his system; and his Conclusion was published 1739.

His long practice of that system for near forty years, open to the inspection of the public, gave opportunity of detection, if what he advanced had been false; and he says, in his Addenda, 1738—"Neither has any of the opposers produced one single instance where this scheme, tolerably well executed, has not had a reasonable success. I am sure I have never known such
an

an instance, and doubtless if there had been any such, some of the opposers would have produced it."

All allowed him intelligent, nor did even those violent opposers, or any other, attempt to attack his veracity.

But the singularity of his scheme caused him to be reprehended as whimsical and fanciful, and obstinate in continuing a scheme so long, by which he hurt his fortune : but this he expressly contradicts.

In his Notes, or Supplement published 1736, three years after his Essays, he says : " Before I conclude my notes, I will give an answer to a very false and malicious assertion of the Equivocal Society, in their essay for July, in these words :

" The proprietor himself, instead of raising one estate by this and other new invented pieces of husbandry, has well nigh spent two.

" These latent authors must be very conceited in their own penetration, if they know my affairs better than I do.

" If I know them, I have been so far from spending an estate in any manner, that my circumstances are better than when I first set out in the world, notwithstanding many misfortunes, amongst which the loss of health, which obliged me to quit the profession to which I was bred, and to travel for saving my life, may be reckoned.

" It is to the new husbandry that I owe the property of my farm : and all that I here have said, I can make appear to any gentleman, whose curiosity shall induce him to enquire of me to find the truth ; whilst not only many farmers in my neighbourhood have broke, and several gentlemen farmers have lost more money than all I have is worth, by the old husbandry, in the time I have been practising my scheme, though generally the first inventor of a project is a loser."

He by no means appears obstinate, as he made gradual

dual progress by his variety of experiments, and altered his method when he found another better.

He says, "I have been at much charge and expence in improving my drills for planting rows at narrow distances, making some rows at $3\frac{1}{2}$ inches, others at 7 inches asunder, and sowing different seeds at different depths. But I am since, by experience, fully convinced of the folly of these, or such mixed crops, and more especially of narrow spaces.

That I have destroyed these instruments as a vain curiosity, the drift and use of them being contrary to the principle and practice of the horse-hoeing husbandry."

In another place he says, "the practice and instruments that are left off for better in their room, as the quadruple and treble rows, are still useful to be shewn, in order to deter others from getting into an inferior method, that is now exploded; for some might think it an improvement of the double rows by their own invention, if they should not know it had been tried."

He also shews he is by no means obstinate, and that he had not determined without full experience: For example, in the preface to his *Essays* published in 1733 he says, "raising constant annual crops of wheat without dung or manure, is as yet only on probation; but by 6 crops I have had in this manner, I see nothing against their being continued."

He began drilling about 1701 with equal distant rows for hand hoeing, and made many experiments.

His horse-hoeing	-	-	-	1721
His successive crops	-	-	-	1726
And in his Conclusion mentions	}			1739
his 13th successive crop				

His thus continuing his method for so many years, is not to be considered as obstinacy (with which he is taxed), as he changed his method when he found another superior."

He

He says, "if I am taxed with levity for my changing my treble rows for double ones; it will not appear to be done on a sudden. When the reader turns back, he will find in my directions, I advised double ones, and a trial of both sorts: and now upon further experience I find the double rows much preferable to the treble rows, especially for wheat;" and he further says, "this is the best, and I publish it as such, without partiality to my own opinion; for I think it less dishonourable to expose my errors, when I chance to detect them, than to conceal them; and as I aim at nothing but the truth, I cannot, with any satisfaction to myself, suffer any thing of my own knowledge to escape that is the least contrary to it."

And in the notes on his preface, page 248, he says, "The matters of fact I have related are not like some stories told by travellers, hard to be disproved if they are wrong."

"It would have been rather against my interest than for it, to relate any fact falsely: none being acted at so great a distance, or with such privacy, but that any one, who would take the pains, might satisfy himself, as several noblemen and gentlemen did by ocular inspection."

* And he advises every one who begins the culture he recommends, not to trust to him, but to try it, and satisfy themselves before they venture drilling great quantities.

This shews he is not conceited or dogmatical in his own system, but desires others to make trials. From these instances of his, and others, and his candid impartiality, without prejudice, we must allow the long experience of such an author to have great weight to induce farmers to try his method, as we see the success others, who had made trial of it, found: and it is contradicted by none but trifling experiments and

* This he mentions in his addenda, published 1738.
calculations

calculations, and those made without drills, or with such as were very unfit for the purpose. This defect is now remedied by many drills, which from experience of years are found sufficiently strong; but the defect of drills was no defect of the system, although it stopped the progress of this husbandry.

Mr. Tull, in his essays, gives an account of what induced him to begin the practice of drilling.

“Having a farm in hand he resolved to plant it with saintfoin. He began to examine whether seven bushels per acre (the quantity sown) was necessary. and says “I observed in several fields of saintfoin, that in those parts which produced best crops, there were (having counted them) about one plant for each square foot of surface, &c. I then employed people to make channels, and sow a small portion of seed therein, and cover it.

“This way succeeded to my desire; but next year, as soon as I began to plant, I discovered that the people had conspired to disappoint me, and never to plant a row tolerably well again. I resolved to quit my scheme, unless I could contrive an engine to plant it more faithfully, than such hands would do: I composed my machine, it planted that field as well as hands could have done; and thirty years experience shews saintfoin thus planted, lasteth longer than saintfoin sown.”

This drill has been used almost as long in planting all sorts of corn for hand-hoeing, and these nine years for horse-hoeing. This account is given in his specimen published 1730: the hoeing scheme, as formerly mentioned, was taken from the vineyards.

“The quantity of seed to be drilled on an acre is much less than in the broadcast, or common husbandry; not because the hoeing will not maintain as many plants as the other; for on the contrary, experience shews it will always maintain more, but upon many other accounts. It is impossible to sow it as even by

hand, as the drill will do; for let the hand sow it ever so exactly, the unevenness of the ground will alter the situation of the seed. The greater part either falls into holes and low places, or is drawn into them by the harrows: these places have consequently ten times too much, while the higher parts have little or none, and of that little, the greater part perishes for want of sufficient covering. The efficient quantity of seed is greatly lessened by both causes, for fifty seeds in the space necessary for one, will not produce so much as one will do."

The distance which Mr. Tull found to produce the greatest crops was 2 rows upon a ridge of 4 feet 8 inches, with 10 inch partitions. This was drilled with 3 pecks per acre, which, by the table is 82 grains per yard of single rows, or 164 per yard of double rows: by this, each grain drilled has a space of $12\frac{3}{4}$ square inches. In the BROADCAST a great deal of the seed is lost by the means above mentioned, and destroyed for want of nourishment by the weeds, as well as by the plants that do not come to perfection, robbing those that grow, of a great deal of nourishment. From this cause we see so small crops from so great a quantity of seed, and so many small ears, many of them having only five or six small grains per ear. The BROADCAST, if sown with $2\frac{1}{2}$ bushels, by the table, each grain has only a space of $3\frac{1}{10}$ square inches. In the DRILLED, the seed is placed more regular, planted at the proper depth, properly covered, and has more space to draw nourishment from; and therefore it may be expected that most of the seed will be productive; and we see that it does produce much larger ears. Besides, plants that have more space and nourishment, produce more tillars, some having no less than 50 ears after 1 grain; and as the ears are at least 3 times larger, this would make an equal produce from the third part of the number of ears.

He says, as to the depth, we may plant from half an

an inch to three inches deep. Mr. Clarke in his Theory and Practice of Agriculture, states experiments which he made: he planted grain of different kinds, and different depths from 1 inch to 8, and he concludes from his experiments, that from 2 inches to 5 is the properest depth.

He gives reasons for that being the proper depth, to which I refer the reader, who wishes information of the theory. He also shews the good effect of rolling ears in the spring, as it tends to promote the tilling and earthing up the plants, which has the same effect, as both give the plants more earth, which promotes the knots, or crown roots, and increases the tillars.

Another experiment was to try the effect of thick sowing where the soil was deeper: two boxes, each 12 inches square, and 10 deep, were filled with rich soil. In one box, 144 seeds of wheat were planted; in the other 36. The box which had 144 seeds produced near half a pound, and the box with 36 near three quarters of a pound.

Mr. Millar finds fault with sowing too thick, and says, "If farmers will but examine a field of corn sown in the common way, they will find but a few roots, which have more than two or three stalks, unless by chance, where there may be some few roots that have room to spread, upon which there may be 6 or 8 stalks or more; but in a field of wheat that had not more than one bushel per acre, so that the roots had room to spread, I have observed that the roots produced from 6 to 12 and 14 stalks, which were strong, and had long well-nourished ears; and the produce was much greater than in any of these fields in the neighbourhood, which were sown with the common allowances: and if the land is good, and the roots stand at a proper distance from each other, there will be few roots that will not produce as many stalks as I mentioned, and the ears will be better nourished."

Mr. Millar also recommends thin sowing, and says, "If the land is not covered with blades of corn by spring, the farmers think they shall have no crop; whereas if they would have patience to wait till the roots put out the stems, they would soon be convinced of the contrary, especially if they could be prevailed upon to draw a weighty roller over the wheat in March, which will cause it to spread; and by settling the loose ground to the roots, the drying winds will be prevented from penetrating to their fibres, and so they would produce more stalks. He recommends, in imitation of the practice of the kitchen gardeners, to cut up the roots of corn, where too close. What I mention is not from theory, but experiments which have been repeated with great care, and where it was practised, the produce of twenty roods of ground was much greater both in weight and measure than that of the same quantity of ground in the best part of the field, where this was not practised; and the stalks stood upright, when a great part of the corn in the same field was lodged."

He likewise recommends *drilling barley*, and sowing it thin. He states the common allowance of seed to be four bushels to an acre.

"If they (the farmers) could be prevailed upon to alter their practices, they would soon find their account in it; for if a third of that quantity is sown, there will be a much greater produce, and the corn will be much less liable to lodge, as I have many times experienced. For when corn or any other vegetable stands very close, the stalks are drawn up weak, and so are incapable of resisting the force of the winds, or bearing up against the rains. I have frequently observed that in fields, where there has been a foot-path through the middle, the corn that has stood thin on each side of the path hath stood upright, when all the rest on both sides had been laid flat on the ground; and whoever well observes those
roots

roots of corn near the paths, will find them fuller, or branch to more than four times the quantity of the other parts of the field. I have seen experiments made by sowing barley in rows, across divers parts of the same field, and the grain sown thin, so that the roots stood 3 or 4 inches asunder in the rows, and the rows at a foot distance. The intermediate spaces of the same field, were at the same time sown broadcast in the usual way. The success was this; the roots which stood thin in the rows tillured out from 10 to 12, to upwards of 30 stalks in each root; the stalks were stronger and the ears longer, and the grain larger than any sown in the common way; and when those spots sown in the common way have been lodged, those parts sown thin have supported the upright position against the wind and rain, though the rows have been made not only lengthways, but cross the lands in several positions, so that there could be no alteration in regard to the goodness of the land, or situation of the crop.

“ Hence, where such experiments have been frequently made, and always attended with a like success, there can be no room to doubt, which of the two methods is most eligible; since, if the crops were only supposed to be equal in both, the saving two thirds of the corn is a very great advantage. For if it is sown in drills, one eighth part of the seed usually sown will be sufficient for an acre of land, and the produce will be greater; for all sorts of corn are naturally inclined to send out several stalks from the roots, which they rarely fail to do, where the roots are at a proper distance, and have room; I have counted 86 stalks upon one root of barley, which were strong, and produced long ears, and the grain better filled than any I ever saw grow in the common way; and the land upon which this grew was not rich. I have made many experiments for several years in the poorest lands, and have always found,
that

that crops, which are sown, or planted at a greater distance than usual, have succeeded best upon such lands. Many think unless there is a great deal of seed sown in poor land, their crop will not be worth standing, which is one of the greatest fallacies that can be imagined, for to suppose that the poor land can nourish more than twice the number of roots in the same space that rich land can, is such an absurdity as one could hardly suppose any person of common understanding to be guilty of."

One great reason for the farmers sowing so much seed is to destroy or keep down the weeds, as the crop being thick prevents them carrying seed, which would greatly hurt the succeeding crops by their multiplying, were they to produce seed, and they think that this additional quantity of seed is only so much lost, and does not exhaust the ground more than the weeds would have done; but this additional quantity of seed exhausts the ground, and those small ears and weak stems that do not come to perfection deprive those that do grow, of so much nourishment, and thereby lessen the crop. They prevent a free circulation of air, and intercept the dews in their passage to the roots, so that instead of being absorbed by the fine earth, refreshing and enriching the crop, they are exhaled by the sun.

Experience has shewn that good crops of wheat may be produced by the drill husbandry from land which at present is not thought fit for it. One great advantage to the public, were this mode of husbandry more general, would be, that it would furnish employment to the industrious poor, men, women and children, who might be employed in weeding and hoeing, who can do nothing else at a distance from manufacturing towns. Such of them as are willing to work deserve the attention of the public, especially when they can be usefully employed. Their labour becomes an addition to the public stock, and their industry,

industry, a source of profit to their employers, instead of loading them with a tax. As for those whom vice and idleness render a burthen to the parish, they deserve punishment in place of maintenance.

It is objected that this husbandry cannot come into general practice for want of hands to hoe great quantities of land. This was an objection against the culture of turnips, when first introduced. In many places, no doubt, were it introduced all at once to a great extent, there might be some difficulty in finding hands at first. But one instance I have seen, where turnips were first introduced. The proprietor could get little more than 10 or 12 acres hoed, and that too by procuring the assistance of gardeners from his neighbours. But in a few years, within six miles of his farm, there were at least 500 cattle fed upon turnips, all well horse and hand hoed. Some farmers fed 100, and found no difficulty or want of hoers, as old men, women, boys and girls were all employed.

By this mode of husbandry, there is not only greater crops with a great saving of seed, but the quality of the grain is much improved.

Mr. Tull mentions, "that some cone wheat was taken out of the same heap, and some of it planted, and some sown broadcast all at the same time, on land of the same sort. The wheat that was sown produced grain, that was so small, and that which was drilled, so very large, that no farmer would believe it to be the same wheat, except those who knew it, which were many. One grain of the drilled weighed two of the sown, and there was twice the weight of chaff in an equal weight of the sown."

The practice of drilling has been used in Kent, in what is called the round tilth, by drilling beans and sowing wheat and barley broadcast, and many drill all other grain. In the Annals of Agriculture, Vol. II. in the author's tour in Kent and Essex, he maintains, that sowing beans in rows, was in use there above one hundred

hundred years ago. He says all the best farmers put in their wheat and spring corn also in the furrowing way. By striking the land into furrows by a plough at 11 or 12 inches, the wheat arises to 5 quarters, but 4 are reckoned a good crop. It also is shewn that the best farmers approved of the drill husbandry, and practised it. The round tilth of Kent shews the great benefit of drilling, or furrowing and hoeing, as by the assistance of that, they have great crops of broadcast wheat, barley, and drilled hoe beans, which are horse-hoed in the 9 inch partitions, with schims for that breadth, and well hand-hoed in the rows.

In the 4th vol. of the Annals are several letters from very intelligent practical farmers. Mr. Hall, who practised the drill husbandry, says, "I make no fallow, and yet my land is very clean, the first, second, fourth and fifth crops being always furrowed and well schimed, peas should be hoed twice and schimed four times. He adds, the plough used for wheat, barley, and oats, (one plough answers the purpose for these several sorts,) makes two furrows at a time; the barley I generally drill, not sow: For peas the plough makes only one furrow at a time, and drills the peas. I reprobate the method of my neighbours in sowing their lands constantly with wheat, barley and beans—If they will continue their old plan, it would be better to furrow their wheat and barley that they might hoe it. But it is supposed by many, that furrowed crops will not be so great, as if sown broadcast.—I am of a different opinion, and have grown the greatest crops of corn when furrowed."

In the 5th vol. of the Annals, p. 446, where he mentions his method of drilling, he says, "If wheat is drilled in the same direction as the furrows, it is impossible to perform the work with a single drill plough (here generally used for wheat and barley), I conceive the work cannot be done on highly arched ridges with the furrow." This shews the practice of
drilling

drilling by some of the best farmers, and that no prejudice ought to be entertained against it from an idea of its novelty.



INTERVALS.

HAVING shewn the advantages of drilling over the common mode of broadcast sowing; we come next to inquire what extent of intervals ought to be left between the rows of a drilled crop.

When Mr. Tull began his horse-hoeing scheme, he drilled 3 and 4 rows upon ridges of 6 feet. After some years experience, he made his ridges only 4 feet 8 inches, and drilled only 2 rows on each. "I have now," he adds, "entirely left off the middle row for wheat, and keep only to the double row, which I find to be much preferable. The cleaning from weeds is less difficult, than when there are three rows. The hand-hoe cannot give near so much nourishment in two seven inch partitions. There is less earth to be pulverized by the plough, than in a ridge that hath one ten inch partition."

The ridges must be twice as deep in the middle for treble rows, as for double, and as ridges may be made lower, that have only one ten inch partition, so the intervals may be narrower.

The reason for adding a middle row was, as an ally to the exuberance of the other two, when they were of the lammas sort: when gentlemen saw the middle rows upon low ridges so much inferior to the
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outside rows, they were convinced of the effects of deep hoeing, as there was no reason for this, except the outside rows standing near to the pulverized intervals : when on high ridges, the middle row was nearly, or quite as good as one of the outside rows. I suspected, that the latter were diminished by the middle row, as much as the produce amounted to ; and this I found actually to be the case ; for 4 rows of oats without a middle row produced somewhat more than the same number that has a middle row ; 2 of which treble rows were taken on one side, and 2 on the other side of the double rows, purposely to make an unexceptionable trial ; and this as far as I can judge is the same in wheat.

“ I have left off making low 6 foot ridges on account of treble rows, which together with 6 foot ridges, I have now left off for wheat.

“ I now choose to have 14 ridges on an acre, and one only partition of 10 inches on each of them ; this I find answers the end proposed ; if the partitions are narrower there is not sufficient room in them for the hand-hoe to do its work effectually ; if wider, too much earth will lose the benefit of the hoe-plough.”

Mr. Tull says, “ the distance of the rows is one of the most material points, wherein we shall find many apparent objections against the truth : which though full experience be the most infallible proof of it ; yet the world is by false notions prejudiced against wide spaces between rows, that unless these common, (and I wish I could say only vulgar) objections be first answered ; perhaps nobody will venture so far out of the common road as is necessary to gain the experience.”

He adds, “ The objections most likely to prepossess people’s minds, and prevent their making trial of this husbandry, are these.

“ First, they will be apt to think, *that these wide naked spaces, not being covered by the plants will not be sufficient*

ficient to make a good crop. We must consider, that though corn standing irregularly may seem to cover the ground better than when standing in regular rows; this appearance is a mere deception, for stalks are never so thick on any part of the ground, as when many come out of one plant, or as when they stand in rows; and a hoed plant of corn will have 20 or 30 stalks in the same quantity of ground, where an unhoed one being equally single, will have only 2 or 3 stalks. The tellured and hoed stalks, if they were planted all over the ground, it might seem well covered and perhaps thicker than the sown crop commonly is, so that those hoed rows seem to contain a less crop—they may contain in reality a greater crop than the sown.”

The next objection is, *That the space or interval not being planted, much of the benefit of the ground is lost, and that the crop of course must be less than if it was planted all over.*

In answer he says, “It might be so, if not horse-hoed, the roots run through the intervals, and having more nourishment make a greater crop.

“In a large field of wheat, it was proved, that the wide-hoed intervals brought the best crops of all. Dung without hoeing, did not equal hoeing without dung, and what was most remarkable among 12 differences of wide and narrower spaces more and less hoed, dunged and undunged, the hand-sowed was considerably the worst of all; through all the winter and beginning of spring it made infinitely the most promising appearance, but at harvest it yielded only about one-fifth part of wheat to that which was most hoed. There was some of the most hoed, which yielded 18 ounces of clean wheat per yard in length of a double row. The intervals being 36 inches, and the partition 6.

“One like yard of a hoed row of wheat in an undunged field, produced 400 ears of lammas wheat.

“ *A third objection of a similar nature to that of the two former, is, that so small a part of the ground as that whereon the rows stand, cannot contain plants or stalks sufficient for a full crop.—But, since plants thrive, and make their produce in proportion to the nourishment they have within the ground, not to the room they have to stand upon it—one very narrow row may contain more plants than a wide interval can nourish, and bring to their full perfection, and it is impossible a crop should be lost for want of room to stand above the ground, though it were less than the 10th part of the surface.*”

Mr. Tull again says, “ *I have particularly observed, that the more successive crops are planted in wide intervals, and often hoed, the better the crop is sustained, the last crop is still the best, without dung or changing the plant.* This is visible in parts of the same field, where some part having a first, some a second, the rest a third crop, growing all at the same time, which seems to prove, that as the earth is made by this operation to dispense or distribute her wealth to plants in proportion to the increase of her inner superficies, so the atmosphere, by the riches of rain and dews does annually reimburse her. But if the superficies be not increased to a competent degree by frequent repetitions of hoeing, this advantage is lost, and without often repeated manuring every year grows worse.

“ And it has been made evident by trials, which admit of no dispute, that *hoeing without dung or fallow*, can make such plants as stand in wide intervals more vigorous in the same ground than common dunging and fallow can do without *hoeing*. We augment our wheat crops not in number of plants, but in stalks, ears and grains.

“ 1st, by encreasing the number of stalks from 1, 2, or 3, to 20, or 30 in ordinary field land.”

“ 2d, We augment our crops by bringing up all the stalks into ears; for if it be diligently observed,
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we shall find not half the stalks of sown wheat come into ear.—3d. And by augmenting the ear to a much greater size.

4th. By causing them to have large and plump grains. Thus by increasing the number of stalks, bringing more up into ears, making the ears large and the grain plump, the hoeing method makes a greater crop, than the sowing method can.

These advantages will be lost to those drillers who do not overcome the unreasonable prejudices of the inexperienced concerning the width of the intervals. In wide intervals we can raise a good crop with less labour, less seed, no dung, or fallow; but not without a competent quantity of earth, which is the least expence of any thing given to corn.

Though too great a number of plants be upon many accounts injurious to the crop, yet it is best to have a competent number which need not be exact; but we may expect good crops from forty or fifty plants in a yard of treble rows if well managed.

In opposition to the idea that the roots of wheat extend but a small distance, and that the wide intervals are best; it has been shewn formerly, that where plants have space, they tiller and produce many stalks, and that two rows have yielded eighteen ounces.

Mr. Tull mentions an instance to shew that roots extend through six feet ridges.

“ When the south end of some of the ridges, and the north end of others had their partitions hand-hoed and cleaned in spring, the opposite ends remaining full of weeds, the next year, the whole field being drilled again, exactly in the middle of the last intervals, shewed clearly how far each ridge had the partitions cleaned. The crop of the former was twice as good as the latter, although both were cleaned of weeds next spring.”

This crop standing upon that part of the mould, which was the farthest from the rows of the preceding crop,

crop, proves, that both the roots of wheat and weeds did enter the earth of the former intervals.

It was observed, that where the partition of two of the six feet ridges had been cleaned of weeds the preceding year, and those adjoining not cleaned; the rows that were planted in the middle of the intervals, between those, were perceptibly better than either of the two rows planted in the intervals on each side.—The reason of this must be, that the middle of the interval of the two cleaned ridges was fed on by the wheat only, and by no weeds: but the other two intervals were fed on by the wheat on one side, and weeds on the other side of each.

Mr. Tull says, “By an experiment of turnips it appears, that the roots must have extended three feet, as a field drilled with turnips at one side and the two ends as well as the ridges, were not hoed, or ploughed. The other side of the land was ploughed and hoed. The three rows of turnips, next to this ploughed ground, was much larger, and more flourishing in colour; even the turnips in the rows, which stood farthest from the new ploughed land, received so much benefit from it as to grow twice as big as any of the more distant rows. The row one foot nearer the new ploughed land, was twice as large as that farther off, and the row next the ploughed land still larger.

In the middle of this piece, next to the ploughed land, was a piece of unhoed ground, by a bend or turn of this ridge, (the drilled turnips being in straight lines of about two perches in length, and about two or three feet broad, lying between these two lands, which had not been ploughed that year) it was remarkable, that during the length of this interjacent hard ground, the rows of turnips were as small and yellow as in the land.

The turnips in the rows about three feet distant from the ploughed land, receiving a double increase, proves that they had as much nourishment from the ploughed

ploughed land, as from the land on which they stood. They must have extended at least one yard, else they could not have reached the ploughed land, so as to give each turnip as much increase, as all the roots had done in their own land.

Mr. Millar says "he has traced roots upwards of three feet, and mentions an experiment, shewing that drilled wheat produced from 20 to 30 stalks, and that of the common husbandry only two or three.

Mr. Randall, in speaking of Mr. Tull's experiments and practice says, "The ground ought to be extremely well fallowed, and the weeds destroyed, before any should attempt to imitate Mr. Tull's method of husbandry. If he follows his directions, the poor thin soils will be of great consequence ever afterwards. It will undoubtedly produce more after it has been two or three years in this course without dung, than ever will be effected by the usual form of husbandry. Mr. Tull, as far as he thought proper to give his thoughts on vegetation, has demonstrated that he was a gentleman of great skill and penetration, and all variations from his method of improving the intervals, when the corn is drilled, are departing from that bias. I have tried his method often enough to convince myself of the great utility of it. I should have continued Mr. Tull's method of growing wheat, had had I not been tired out by servants, &c. This induced me to think of some other method to prevent these difficulties."

In mentioning the intervals he says, "Here the ploughman has sufficient room every year to obtain two excellent ends: first continuing the ground in a state of fineness, and that to a good depth; and thereby the benevolent atmosphere supplies the external and internal pores of the poor soil with nutritive principles. The ground being thus always replete with proper nourishment, and kept intirely free from weeds in all respects, superlatively prepared to promote the strength

strength and vigour of wheat : secondly, while this end is obtaining, or the business of vegetation going forwards, the ploughman is preparing his fallow for the next season."

Wheat standing in rows eighteen inches asunder throughout the ground, and weeding these spaces by a single horse-hoeing, is undoubtedly doing service to the crop; but yet it is greatly short of the perfection attainable by Mr. Tull's Method, as it is not reasonable to expect the ground so well prepared (by this single horse-hoeing, or going an inch deep) for a crop of wheat another year; yet this may be a very good method for those who have not faith enough to think Mr. Tull's two rows on six feet of ground, will produce upon an average, a crop of eighteen bushels of wheat without dung, or throw the land up every fourth year for a fallow.

We had a mind to be satisfied of this, even from various distances of the rows, planting some at two and a half, and others at three feet. The consequences of which were, that the ground was improved, but not the crops; from which we inferred, that next to Mr. Tull's system of intervals, and partitions of six feet, the only choice is the rows at eighteen inches asunder through the ground. Those who have got into Mr. Tull's method of cropping their poor thin soils, and those who can contrive a device to effect the same, I am sure will not have any reason to repent, but the contrary."

In treating of loams, and light deep ground, he says, "As by Mr. Tull's own farm, twenty-four bushels upon a medium may be obtained; it is found by experiment, a good crop may be obtained by drilling rows about eighteen inches, if the ground is in good heart twenty-four bushels of wheat may be expected upon a medium. It is a more eligible method than the common practice of raising crops of
wheat,

wheat, as it saves three parts out of four of the seed, besides dung and the damage of weeds.

The reader may expect to have a reason assigned for Mr. Tull's own method producing as good a crop upon a medium, as that from rows at eighteen inches, especially as there is double the quantity of seed and ground in the one case there is in the other. They are both fact, whether we can assign a reason or not. I believe the only reason is the different degrees of looseness of the loam in both cases; and the difference of Mr. Tull's horse-hoe, and that drawn by one horse. It must be owned, though the latter keeps the weeds from damaging the corn on the ground, and growing up with it, yet I have often observed this method of horse-hoeing between rows of eighteen inches, is undoing what was done before: for by the horses and servants going three or four times in the season between the rows, they press the loam together, and by that means it grows too hard beneath, for the long fibres of the roots to penetrate, notwithstanding it looks loose and fine, as far as the shares of the single horse-hoe reaches. But by Mr. Tull's method of horse-hoeing, this damage to the ground is not to be expected, as every operation takes off the tread of the horse's feet."

Drilling barley by the new husbandry, in rows at eighteen inches, is preferable to the common husbandry, and has all the superior advantages in the same maner as the wheat, if the loam is in good heart, and fine, and clear of weeds, the barley will meet, and every way satisfy the reasonable expectation of any gentleman, when compared with the common crops upon a medium, provided there be care taken to prepare the soil.

"From what has been said, we infer, that where the soil is poor, and shallow, and stony, the drill husbandry is inferior to the common practice. Where the soil is poor, light and unstonny, the drill husbandry

dry of cropping the ground successively with wheat, till the return of the fallow season every fourth year, is superior to the old husbandry."

It appears also, that the roots cannot penetrate and extend their fibres to receive nourishment, unless the ground is opened and pulverized by tillage and hoeing, or manure; and where they have more space to extend their fibres, they extend above three feet, and produce larger ears, and a much greater crop. It is certain plants grow according to the nourishment and vegetable food they receive by extending their roots, or collect from dung or manure, and not according to the ground they stand on; therefore a single or double row may contain as many plants as the whole space of the interval could nourish; and if they were scattered all over the ground, or planted irregularly, so they would have much less nourishment, because when drilled in rows, the earth is deep horse-hoed, and every horse-hoeing gives a fresh supply of nourishment to the plants, which they could not have, were they planted irregularly over the ground.

A statute acre is 220 yards in length, and 22 in breadth, or 66 feet. If the rent of the acre is 16s. 6d. this would make the rent of every foot in breadth 3d. If the ridges were 3 feet 6 inches, this would make 19 ridges, in breadth, and the rent of each would be 10½d.

If 1 foot was added to each in breadth to make them 4 feet 6 inches, this would reduce the number of ridges to nearly 15, and the rent would be 3d. of addition to each, which would make them 1s. 1½d. per ridge, or nearly 3s. 9d. to the 15.

This a farmer should not grudge, as thereby, and by the hoeing, the expence of dung is saved, which is at least as many pounds, and besides it is shewn the space is not lost.

And also this enlarging the breadth of the ridges is a saving of expence, as by reducing the ridges from

from 19 to 15 makes 4 ridges fewer, which is a saving of hoeing these 5 times or 20 hoeings, which is more than hoeing an acre once, which in the expences is stated 1 shilling. Also in hoeing the partitions, twice this is a saving of 8, or nearly one half.

If the price of hoeing the partitions of an acre be stated at 2 shillings, this is a saving of 1 shilling, besides the hand-hoeing of 8 double rows.

The additional earth added to the ridges is stated at 3s. 9d. and the saving 2 shillings. The difference is only 1 shilling and 9 pence, to save the expence of manure. This assistance is at hand.

A farmer, if his land require 20 cart load of manure, (of which he has plenty at his command,) and should not lay it on, because the driving would cost five shillings, would be thought ridiculous. Neither should the drilling farmer grudge this expence for earth. The repeated hoeing, at the same time that it destroys weeds, applies this manure to the rows, and as has been shewn, the encrease is much greater when the plants have a reasonable space to extend their roots. Their encrease would much more than repay the number of rows diminished by the encrease of the crop, with wide intervals, preparing the intervals better for the next crop.

As the proportion of the earth horse-hoed is greater in a ridge of 4 feet 6, than in that of 3 feet 6, and much better pulverized and exposed; as in the ridge 3 feet 6, the partition of 10 inches, and 2 inches on the outside of each row, takes up 14, and 28 remains for the intervals, and the intervals of the ridge 4 feet 6, is 40 inches. The first is double the space of the partitions, and the other is nearly three times the space of the partitions.

On this subject I shall mention what a very intelligent author (Mr. Forbes), an extensive practiser of this husbandry, says on the drill husbandry. After describing the manner of ploughing and hoeing,

he goes on thus. " By these operations the land is kept clear, open, and in a high state of pulverization all the time it is growing, which so encourages the plants to spread their roots to form new ones, and furnishes them with abundance of nourishment, that they tiller, or branch greatly, and produce large ears, and are fuller of grain than wheat sown broadcast with three times the quantity of seed.

" It may appear extraordinary to many, that good crops of wheat can be raised upon ordinary land by so small a quantity of tillage, and that successive crops can be raised without dung; several circumstances concur to produce this. The drilled crop while young, requires only a small share of nourishment. It subsists upon the vegetable food remaining in the soil, with what it receives at the first hoeing after harvest. This opens a furrow close to the rows, whereby they are kept dry in winter, which is of consequence to the wheat. Turning a furrow from the rows exposes a large new surface to the influence of the atmosphere, the land receives a new stock of vegetable food. This is an important circumstance, and peculiar to the new husbandry. Land at rest is made fertile by exposure to the atmosphere, and land that is turned up by the plough being open, and in tilth, is much more easily penetrated by the atmosphere than hard stale land at rest, and is quickly impregnated with vegetable aliment. In winter, by the snow, rain and frost, and in summer by the sun and dews, which in hot weather fall plentifully in the night, and are imbibed by the fine spongy soil, as deep as the plough goes, and which is deeper than the sun exhales it in the day. Certain it is that the earth by exposure is greatly enriched, to such a degree as to give sufficient nourishment to the wheat for the repeated annual crops, if it have no other nourishment."

These

These facts and observations are sufficient to prove the superiority of wide intervals in the drill husbandry, and serve also to explain the causes, whence that superiority proceeds. Should any doubt still remain, it will, we trust, be effectually removed by the experiments collected under the head of Comparisons.

Mr. Tull has demonstrated, that the roots of wheat extend a great way, by the instances mentioned of hoeing turnips near to barley, and that of hoeing the ends of some ridges, and leaving others unhoed, (mentioned page 63.)

And Mr. Millar, author of the *Gardener's Dictionary*, says, he has traced the roots of wheat above 3 feet, and mentions two instances of wide spaces.

Mr. Tull, as formerly stated, mentions instances of horse-hoed wheat producing 18 ounces per yard of double rows, and of a yard of rows producing 400 ears per yard.

And an instance is also stated, shewing that wide intervals horse-hoed, produce more ounces per yard, than equi-distant at 9 inches, although it is so great a crop as Mr. Boot mentions of 50 bushels per acre.

The experience and practice of gardeners for many miles around London, who cultivate peas and all garden things for the London market, who allow spaces, and trench or dig the intervals, or plough deep. All these are clear proof of the effects of allowing space, and that the roots extend a considerable length, and produce in proportion to the space allowed, as is found by experience.

From the roots the plants extending their fibres, receive their nourishment; and also from the influence of the atmosphere upon the plants themselves and leaves.

Were it not so, the nine-inch rows would produce as many ounces per yard as the wide spaces, which is afterwards shewn they do not.

When

When plants have space, the stems branch and have more leaves and larger, and imbibe more from the atmospheric dews, rain, &c. which contribute greatly to the nourishment of all plants, which is quite otherwise where the plants are confined and have little space in which case there are few stems or tillers, and few leaves or small ears.

This planters and gardeners find who study nature. But it is less attended to by farmers, and is most observable in that destructive method of allowing trees in hedge rows, to be pollarded, and every branch cut off like a may-pole.

Let one tree or plant of any kind have all its branches and leaves cut off in that manner; or even the leaves only, and another not so; the one so robbed will be much less thriving than the other, and if a tree is thus to be cropt for years, the great difference will be visible by there being less and smaller timber in it than in the other, and in fruit trees less fruit. It is the same with grain, though it is not so strong a plant; by depriving it of what is necessary for its nourishment, you stint its growth and vigour. Had those plants been deprived of what was necessary to them by not allowing space to the roots, and had they been planted so thick as to exclude the air and atmosphere in a great measure, they would be in a poor condition. This farmers see where grain is sown very thick, but do not attend to the cause.

Had those roots and leaves been of no use (as many by their management appear to think,) they would certainly not have been originally formed by the wise Creator.

Although man is allowed to assist nature, and ordained to labour for his food; to counteract nature, shews equal ignorance and presumption.

The great object is to know the proper space necessary to the plants, and how to produce the greatest crop

crop on that space without exhausting the land so as to prevent it continuing to carry successive crops, and to give the land a proper number of hoeings.



CHAP. VII.

PLOUGHING AND HOEING UPON RIDGES.

MR. TULL directs drilling upon ridges in preference to drilling upon flat land; he says, "The heights of the ridges I cannot determine, as different soils may require different heights of ridges, according to the depth, richness and pulverization of the mould. I find by measuring my wheat ridges in the spring, that none of them are quite a foot high, and some of them only 6 inches, but they were certainly higher at first. As wheat always covets to lie dry in winter: so there is no other way to keep it so dry as by these ridges; for when they are after the first hoeing about 18 inches* broad, with a ditch on each side, almost a foot deep, the rain water runs off as soon as it falls. The wide interval which is hoed between the ridges the first time, with two furrows, must have four furrows to hoe it on the level; or else the furrows that are turned from the row would rise up, and a great part of it fall over and bury the row;

* This was when he drilled 3 rows, but by his last method he drilled only two at 10 inches, by which the partitions were only 14 inches.

but

but when turned from a ridge, it will all fall down to the right hand.

Mr. Tull further adds, "I have for these several years left off drilling on the level, and do advise against it, because although the mould should not be wanting for the partitions in deep rich land, yet it is more difficult to hoe on the level, than on the ridges."

Mr. Tull, in his last method with ridges, 14 in the breadth of an acre, or 66 feet: the ridges are 4 feet 8 inches, or 56 inches, with 2 rows at 10 inches, and 2 inches on the outside, leaves 42 to be horse-hoed, there being a double hollow furrow of 18 inches left open in the middle of the interval at forming the ridges, as AA. No. 1, Plate 3.

The two first furrows when ploughed from the rows as B. B. are formed into a small ridge in the hollow furrows, as C. C. No. 2, the bottom of which is as deep as the *sole* of the plough goes. These are not raised, but turned over or set on edge in the hollow furrow; and when this small ridge is returned to the rows, *that is done by one bout*, or two furrows, by splitting this in the middle, and returning them to the ridge from whence they came, as B. B. No. 1, when the hoe-plough is the proper breadth, (as mentioned in horse-hoeing) but if drilled upon flat land, when the first furrows are hoed from the rows, this must be raised up to be laid upon the unploughed land, in the middle of the interval, as D. D. No. 4. This cannot be performed by the common plough properly, as the shape and construction of a common plough is not to raise up the earth of the furrow, but to set it on edge, or turn it over into the last hollow furrow.

Besides this, if the plough was constructed to lift up the earth, and to lay it on the surface at this first hoeing; when this small ridge was to be returned, which is done at one bout, this would only plough back the earth D. D. *laid* there, but would not plough the solid earth, E. E. No. 4, which it was ridged upon;

upon; therefore before this firm ground E. E. could be ploughed, the earth D. D. must be ploughed, or harrowed down into the furrows they came from at F. F. to level the ground, as the dotted lines F. F. No. 3 and 5; and then the solid earth E. E. must be ploughed to the rows, and laid upon F. F. as G. G. No. 5.—And if the furrows are ploughed 8 inches deep, (or 12 as Mr. Tull mentions) this earth would rise so high as G. G. No. 5, that a great part of it would fall over upon the rows, and cover them. It plainly appears therefore, that all these operations would be more laborious and expensive, as well as more difficult; which induced that intelligent farmer to prefer drilling upon ridges to the other method.—Besides, I must observe, that at the first hoeing from the rows before winter, when the plants are young, the triangular board should be used, to prevent the earth that might fall to the left, from hurting the plants; but at the second hoeing from them, this will do less hurt, as they are stronger, and some earth lying among the roots, will have the good effect to make the plants firmer. And when hoeing to the rows, the ploughman should attend only to raising up the earth properly to the rows, and amongst the roots, so as not to bury them, without attending to clearing out the hollow furrows at this bout; as going up once with a double mould-board-plough would do it: and I have found when ploughmen at first were afraid of burying or hurting the plants, and did not raise the earth properly up to the rows, that the earth falls so much from them, that storms of wind and rain made the plants fall so much over for want of sufficient weight of earth on that side, that the last hoeing could not be given without hurting the stems.

I have not the experience of drilling thin gravelly soil; but from the unquestionable authority of those that have such ground, I am informed that they have better crops by making narrow ridges upon such
I. land,

land, as thereby they have a greater depth of the good earth, in the middle of the ridge.

For this reason, the horse-hoeing husbandry on such land should answer better, as it adds so much more good soil to the middle of the ridge where the partitions are, than equal distant rows, where they have a less depth of soil—or than horse hoeing in deep soil, where doubling the thickness is not of such consequence where they can plough deep. But this many farmers neglect, from a mistaken opinion that the roots of corn extend but a few inches.

But with respect to ploughing, it has been found that a deep furrow has the best effects, when the soil will admit of it with propriety. This idea is confirmed by universal practice, and has been recommended by the most respectable writers in husbandry, as will plainly appear from the following extracts and observations.

I shall mention first, Mr. Worlage, who in his *Mystery of Husbandry*, published 1681, says, “If the depth of the mould will bear it, or the nature of the seed you sow requires it; a double plough, the one succeeding the other in depth may be made, or may be performed by two ploughs, the one following the other in the same furrow.”

He mentions an instance of the good effects of deep ploughing from Mr. Platts, (from *Adam's Tool revived*) of a crop ploughed, for with a deep cutting plough and cross ploughed, that produced 15 quarters per acre, for this reason:

When the land is thin, the crops are much inferior to those produced when the soil is thick; for a thick soil, while it affords more nourishment, gives scope to the roots; this is plain from the appearance the crops on narrow ridges make in the middle, where this good soil is collected, and where the furrow can be made deeper.”

With

With respect to want of soil, Mr. Tull gives an instance, where he says, it is the depth and fineness of the ridge on which the success of our crop depends, the plants having nothing else to maintain them, during the first six months; and if for want of sustenance they are weak in the spring, it will be more difficult to make them recover their strength afterwards, so fully as to bring them to perfection. But ploughmen have found a method of disappointing us in this fundamental part of our husbandry; they contrive to leave the trench or hollow furrow very shallow, when in turning the two first furrows of the ridge, they hold the plough to the left, which raises up the fine of the share, and leaves so much of the earth on which the rows are to stand whole and unploughed, that after once harrowing, there does not remain above 2 or 3 inches in depth of fine earth under the rows when drilled, instead of 10 or 12 inches. He discovered the trick, and asked the servant, who answered according to his own theory, "that as the roots of wheat never reach more than 2 or 3 inches deep, there was no need that the mould should be deeper. But these shallow ridges producing a crop very much inferior to the contiguous deep ridges, shewed at once the mistake of my ploughmen."

In addition to this, I cannot help mentioning what is observed by Mr. Randall, author of the semi Virgilian husbandry, who practised the drill husbandry to great extent, and made a variety of trials of the different methods and distances; he found great advantage from trench ploughing by one plough following another. And by what he calls *double ridge work*, which is ploughing the land into small ridges, by laying 2 furrows together, by which it is more exposed, which he describes. He mentions the fault Mr. Tull takes notice of, the effect of bad ploughing, and says, "unless the ploughman keep the plough square in the ground, a small deviation in holding up the right

hand, will leave the soil in a very bad posture beneath the surface ; and if this is not guarded against, we may as well not sow the seed, for it is impossible any crop should be produced, unless the ground be cut true and square, as far as the staple reaches. Could the soil be divested all at once of the stratum, it would frighten the owner to see the bottom, where the sole of the plough has worked, like so many inclined hills and vallies, by that scandalous practice in some, of holding the plough on one side, as the horses draw it along through the ground. The consequence of this wretched defect in some servants is, that they leave the bottom of the soil in inclined planes, whose base is about $8\frac{1}{2}$ inches, and the perpendicular height $2\frac{1}{2}$, by which there is $\frac{1}{4}$ th part of the staple unploughed. I verily believe more people have been ruined by this unhappy defect, than many gentlemen are willing perhaps to think. We may suppose the staple of these poor lands to be 5 inches, and it may be observed, that the uppermost parts of the inclined plane mentioned before, is about 2 inches and a half below the surface, and that the lowest part where the plough runs upon the edge, is about 5 inches, and the breadth of the plough 9 inches. Now the section, or quantity of earth moved by the plough should be 9 inches by 5, which is 45 cubic inches ; but by being only $2\frac{1}{2}$ inches deep at one side, this leaves a fourth not ploughed, which is not only useless, but a great hurt to the corn that does grow, as it is not only deprived of $\frac{1}{4}$ th of the nourishment, because the fibres cannot penetrate this hard earth, but by the inclined plane are prevented running along freely in the pulverized earth above it." *See Plate II.*

I have omitted Mr. Randall's Mathematical Demonstration, which may not be understood by the generality of farmers.

Ploughing deep, when the soil admits of it, is of great consequence, but great care also must be taken of

of the manner in which the plough is conducted and held. I shall not use my own words, but repeat what Mr. Cook has said, and likewise lay down his exact reasoning on deep ploughing, and good effects of drilling. The underside," he says, "of every furrow should be cut parallel to the surface, and a smooth under floor polished by the plough, forming a plane with an uniform descent from the top of the ridge into the water furrow, upon which polished floor, all superfluous water would readily find its way to the water furrow. But the method of conducting the ploughs in many parts of this kingdom, has a direct tendency to the contrary. By not working their ploughs parallel to the surface, moving them in an oblique direction, they turn over not a square but a triangular furrow, so that the land is not half ploughed, and these are so many ridges of hard earth undisturbed, and channels to keep the water in.

"The soil forming so many trenches, so much of the superfluous water only as remains over filling the trenches, will find its way into the water furrows, and all the water in the trenches remains till evaporated, starving the plants to such a degree, as to hurt the tender fibres of the roots, so as to render them incapable ever after of answering the purpose of promoting vegetation."

"Shallow ploughing has the same defect, of allowing less nourishment to the plants, as the improper ploughing abovementioned, so that fewer plants can be supplied with nourishment in the same space. In the broadcast with $2\frac{1}{2}$ bushels of seed sown, each grain would have only a space of $3\frac{1}{2}$ inches square of surface: if they could be regularly planted, I shall suppose 4 inches. If the ground is ploughed 5 inches deep, this would be 20 cubic inches per grain sown; and the plants would stand at 2 inches distance, if they all grew, and this were sufficient space to nourish a plant.

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But if the staple were good to a greater depth, and ploughed 10 inches deep, this would be 40 cubic inches per plant, and in the same space would nourish twice the quantity. In the drilled land with 3 pecks, sown for horse-hoeing, each grain has a space of 12 square inches of surface, and if the soil be ploughed 5 inches deep is 60 cubic inches, or 3 times the cubic inches of the other, at 5 inches deep, and one third more than the other at 10 inches. If ploughed 10 inches, each plant has 120, or 6 times what the first, and 3 times what the second has. But if each plant required 40 cubic inches to supply it with sufficient nourishment, then the broadcast ploughed only 5 inches deep, could only nourish the one half of the seed; and to have 40 cubic inches for each plant, it must be ploughed ten inches deep; but the drilled land at 10 inches deep would nourish three times the quantity of seed sown on it: The ears of drilled wheat are therefore much larger and fuller of grain than the broadcast, as they have more nourishment; and it is certain that it is not the space they stand on, but the quantity of nourishment they have, that encreases the crop—as upon rich land, twice the number of plants may have as much nourishment as half the number has upon poor land.

And as in a broadcast crop, the ears are never so large as the ears of a drilled crop, there is every reason to believe it is for want of nourishment that they are so much inferior.

In the third vol. of the Bath Society's Papers, is a remarkable instance of the effects of deep hoeing, by Mr. J. Wimpey. He says, "fallowing land has been generally practised to restore its fertility, especially where manure is not to be got in sufficient quantities, and all experience shews that the practice is right. But none have or can have an idea of the great benefit of keeping the soil in a thorough pulverized state, except those who have paid a close attention

tion to it. In a very hot and dry season, I have seen cabbages and other plants which were withering and dying, seemingly beyond possibility of recovery, restored in a very short time to a vigorous state, merely by deep hoeing and earthing up well. I will mention one instance. Of the field of seven acres I used for experiment; about three quarters of an acre was dug with a spade in order to mark the difference between that instrument and the plough; a plat of ground thus dug, was planted with beans in rows three feet asunder, and about 4 inches apart in the rows. It was wheat stubble, very poor and full of weeds, and dug but once. The beans came up well, but the season proved most unpromising. When three or four inches high, they happened to be struck with the blight, and the tops were infected with a great number of insects, not unlike a large bug, which made a great havock amongst them, and threatened the destruction of the whole. I thought a fair opportunity now offered of trying what benefit might be derived from the effects of cultivation. I caused them to be deep and well hoed, and the earth to be drawn up to the stems of the plants. The good effects of this were soon visible: Their verdure soon returned, and they tillured out afresh; the weeds too came up very thick and strong and grew apace. I then had the intervals dug full 10 inches deep, and the weeds in the rows pulled up, this gave fresh vigour to the plants; they headed finely, and totally overpowered the weeds for that season. A few rows of these beans were gathered green, the remainder of the plat stood for feed. The season for getting them in, being rather unfavourable, some of the pods opened, and the beans dropped. As soon as they were housed, the ground was well dug to prepare it for a winter crop. The beans which were scattered, were dug in unnoticed, and before the end of November, were shot up 2 feet high, very strong and luxuriant. I took up several

ral of them carefully to observe the progress of their growth; and it appeared, that in digging the ground, some of them had been buried 7 or 8 inches deep, it being so much from the bean to the surface of the ground; and there, instead of a stalk, had put on the appearance of a root below the bean. The root had penetrated in some 11, in others 12 inches: how much of the fine fibres might be broken off cannot be known. Certain it is, however, that the perpendicular growth of these roots was from 18 to 20 inches: whereas those that were planted in the spring, on the same ground, were much out of condition, very foul, and but once dug, had struck only about 3 inches deep at most. Here then we have demonstration of the surprizing effects, which breaking and dividing, and pulverizing the soil can produce, if done effectually and in proper season. How amazingly great must be the luxuriance of a plant, whose root is 20 inches long, and full of fibres the whole length, if compared with one of the same kind, whose root is 3 inches long and proportionably small."

The writer gives his theory respecting the principles of nutrition, and says, "Supposing the theory to be ever so erroneous, it is of no consequence to the practical husbandman. It is sufficient for him to know and be well acquainted with a mode of practice, which will infallibly render his fields fertile, and capable of producing profitable crops, by means easily practicable, and within his power. That fallowing gives fertility to the earth, is a fact confirmed by universal experience, and well known to every husbandman; but the extent of its power has been considered but by few, and attempted to be carried to its utmost pitch, perhaps by no one. I am of opinion, that even Mr. Tull's mode of practice would admit of very considerable amendments."

Mr. Young, in vol. 5th of the *Annals of Agriculture*, mentions that turnips have declined in their produce,

duce, considerably for the last twelve or fifteen years in Norfolk, and mentions several opinions of the cause: and another circumstance which should be mentioned is, the depth of ploughing in 3 or 4 inches: I have rarely seen 5 inches, and whatever the qualities, deficiency, or circumstances, they are described by the expression common among farmers, that the land is tired or sick of such a crop. Such a state must necessarily take place in proportion to the shallowness of that stratum usually turned up by the plough. For this I would recommend experiments on a deeper tillage, 6 inches. I name 6 or 7, but experiment ought to be tried at 8 or 9. Can any doubt the roots of plants penetrating to that depth, and extracting moisture and their food there? The common objection is breaking what the Norfolk farmers call the pan, or that subsidence that always forms immediately under the path of the plough. But why does it form at 4 or 5 inches deep? because the tillage is no deeper. If that were deeper, the pan would be equally formed, and it would seem on every account more beneficial to have it at that, than at a lesser depth. The moisture thus retained would be farther removed from the powers of evaporation, which in so pervious a soil, must take place strongly at 4 or 5 inches.

Mr. Clarke states an experiment he made to ascertain the depth plants acquired in rich black soil.

Six boxes being 12 inches square, but of various depths from 1 foot; second 10 inches and to 6: these were all filled with the same grain.

These were planted with wheat; the box 10 inches deep produced the best crop, and the crops lessened gradually, as the depth of the boxes to that of 6 inches deep, which was the smallest crop.

The same was sown, a second year with oats, with the like success; that of the box 10 inches deep was the best crop, and that of 6 the worst.

Instances of this I have seen, in both strong and
M light

light soils, where the bottom was hard. In a field that was a clay soil, which had been long in tillage and often manured, the surface was good for 4 or 5 inches, the depth they ploughed. Below that was clay, which was hard by the plough going always upon it. The crops of this field always looked remarkably well and promising in spring, and superior to the neighbouring fields; but in summer turned yellow, declined; and after a hot summer turned out a much worse crop than other fields. This field was fallowed and ploughed several inches deeper by a strong plough which broke this pan, or hard under-stratum; after this it was not so much hurt with the heat in summer, and the crops were better."

Another instance I have seen, where the soil was mostly sand. The road to a house which had been gravelled was altered: this road (I mean the old road) was covered a few inches thick with the soil of the field, and the whole dressed and sown with grass-seeds. Every summer, when there is much dry weather, the grass turns yellow, and shews distinctly where the road was, and in a dry summer is parched and burnt up, when the grass adjoining is much less hurt, and retains its verdure. This instance of the grass is remarkable, as many suppose that the roots of grass do not penetrate deep. If that were so, then the decline must be occasioned by the reflex of heat from the hard bottom, and the moisture being more exhaled here than the other part of the field.

Another instance of the advantage of deep ploughing is shewn in the 10th vol. of Annals of Agriculture, where the practice of Mr. Duckett is mentioned, who drills all his crops at 9 inches. The author says, the great object of inquiry is, by what means he has for so many years been able to keep a farm of more than 500 acres always in crop without a fallow. The first circumstance is his French or shimming plough, which is double shared, the one directly over the other,

other, for the purpose of trenching ; that is taking one narrow, shallow furrow off the surface, and another beneath it. Drilling and horse-hoeing is the next point which has contributed so much to this success.

Many practisers of the drill husbandry are of opinion, that destroying weeds, was the only advantage of drilling and hoeing ; and that plants, whose roots went deep, as some sorts of turnips and carrots, leaving wide intervals, was a loss of so much ground, as they went below any benefit from the hoe ; but these experiments shew that opinion to be wrong : that deep ploughing and exposing the ground is the best means of receiving the influence of the air, atmosphere, rain, and dews, which have great effect in promoting vegetation, and enriching the ground. This was Mr. Tull's opinion, and is now the opinion of many of the most intelligent writers, and practical farmers.

These instances shew the advantage which deep hoeing with the plough has over hand-hoeing, or shallow hoeing with shims. To the latter some intelligent writers attribute the failure of the crops of some practisers of the drill husbandry, who used shims in hoeing in place of a plough, which Mr. Tull and other successful practisers of this husbandry used.

Besides horse-hoeing the intervals with a plough, the partitions may be also hoed by shims, with a horse, as mentioned in Mr. Young's Tours. Those shims are hooked to an axle on two wheels ; the axle extends to the two outer furrows, and the horse that draws them by two shafts, walks in the furrow between the two ridges. They are more expeditious by hoeing two partitions at once, and hoe better and deeper than hand-hoes. By this method, nothing is to be hoed by hand but the weeds in the rows, and a small space left on the outside of the rows. This is but a small expence, and requires but few hoers.

Besides there is a considerable saving in time between fallowing and hoeing. If a farmer fallows 20 acres of his land, this requires 10 days of 2 ploughs to plough it once; and if ploughed 4 times, 40 days, besides harrowing. In horse-hoeing, as 2 ploughs horse-hoe 6 acres per day, they hoe 20 acres in $3\frac{1}{3}$ days, and 4 hoeings are executed in $13\frac{1}{3}$ days, or one third of the time the fallowing requires, and this with 2 horses in place of 4, which some of the first ploughings, after a crop, often require. This, and the saving of $26\frac{2}{3}$ days of 2 ploughs, is a considerable object to a farmer, besides having a crop in place of a fallow, it improves the ground, and prepares it for another.

Mr. Forbes says, "About a fortnight after the second hoeing, when the second hoeing is in the same furrow as the first, the earth should be hoed back to the rows; but if the earth is crumbly and dry at the second hoeing, so as to fall down and expose the plants too much, it should be immediately ploughed back to support them."

He says, "A good horse-hoeing is very serviceable at this time, when the wheat begins to blossom, for this strengthens the plants and blossoms, so that they produce more grain, than if not assisted at this critical time.

"The ears of wheat are formed at first to produce double the number of grains that are found in them afterwards, as may be seen by the naked eye, or by the help of a magnifying glass, when they begin to blow. By this it will be plainly seen, that more than half the blossoms are abortive for want of nourishment. It is therefore of great importance to assist the plants by a good and deep horse-hoeing, when they begin, or a little before they begin to blossom, a horse-hoeing is necessary at this time; as in some seasons and some climates the weather may be so rough when the

the ears are so heavy, that the wheat cannot be hoed, which would be an injury to the crop. But this will not be so injurious, if it has been well hoed at the time of its blossoming.

“ And, if the wheat stands fair, the next hoeing after it has done blossoming, will also be very serviceable to nourish the wheat well then, and cause the grain to be large, plump, and full of flour.

“ Mr. Tull’s last practice was, to give 4 hoeings, and the fourth turned the earth from the rows; turning the earth from the rows the last time is not convenient; for as the next crop of wheat is drilled upon the intervals, more ploughing is necessary to form the new ridges, when the last is from the wheat; for which reason I would advise the young farmer to hoe the earth to the rows the last time. In this way he would hoe three times from the rows, and twice to them.”

As the success of this husbandry depends upon the proper hoeing and pulverizing the land, which many who have tried it did not understand, they departed from Mr. Tull’s directions from a mistaken opinion, that destroying the weeds, and sowing in rows, was all that was necessary, and that if they could save labour, by using shims or miners, or save a hoeing with a plough, they made an improvement: but instead of improving, they were departing from the principle of pulverizing and exposure, and were acting much in the same way as if a broadcast farmer should give his fallow a shimming in place of a ploughing.

Mr. Tull mentions, that hoeing early in the spring is of consequence by occasioning the tillering, of which he gives an instance in his Addenda. “ Two fields, whose staple was a cold land, lying upon chalk, had two successive crops, horse-hoed, of black oats. After that exhaustion and little pulverization, the crop of wheat

wheat was drilled in double rows, 14 ridges in the breadth of an acre. This was the 4th crop without a fallow. I was persuaded to suffer these two fields in such bad circumstances to be planted. And when I got abroad in the spring, I was in the mind to plough it up, but it was suffered to stand, and was hoed. But being planted late it could not be hoed, till after the tillering was past, and it was too late to increase the number of stalks by pulverization, though time enough to encrease the bigness of the ears, as in truth it did, for they were as large as any; yet from the fewness of the ears, I judged these two fields to have but half the crop of the best fields. And the parson having threshed out his tythe, I am informed it shews this half crop to be 16 bushels to the acre. This present crop is likely to succeed better, because the preceding having single partitions, and lower ridges than the oats had, there was much more pulverized earth in the intervals for this present crop."

The effect of hoeing improperly I had an instance of in an experiment made some years ago. The season was so wet after the wheat was sown, that it could not be hoed before the winter; and by the neglect of servants, and rain in the spring, it was not horse-hoed before the end of April. The second hoeing was done in two weeks after. There was three different growths; first the original stems, and one later from the tillers from the first hoeing; and a second also of the tillers still later from the second. These appeared to have branched from the stem at the time of the two first hoeings. As the first tillers appeared much more numerous than the original, or first stems, the crop was allowed to stand, until the first tillers were ripe for cutting. By this the first growth or original ears were lost, as the straw was so brittle, they broke over with the wind; the second tillers or branching was
not

not ripe, when it was reaped. From this it appeared that the hoeing occasioned the tillers to spring. In making several experiments afterwards, the horse-hoeing was performed as early as possible before winter, and in spring, and the wheat was equally ripe. One side of the field in this experiment was near to a field of clover, and the servants horse-hoed the row next the clover only on one side. The side next the clover was only slightly hoed once; and the produce, or ears on this row were not above half the size of the other rows, and did not appear to have put out any tillers.

From this appears the great advantage of early hoeing, as soon as the rows can be distinguished; for which purpose in some experiments, when the ground was full of weeds, from not having been previously cleaned before drilling, I had the intervals hand-hoed for a yard at different places, to mark it for a ploughman.

Mr. Tull says, "it is no great matter whether the rows are drilled on the partitions or intervals, for the crops of a field four years successively drilled on the partitions were very good; but I prefer planting the rows on the preceding intervals. My field, whereon is now the 13th crop of wheat, has shewn that the rows may successively stand upon any part of the ground. The ridges of the field were for the 12th crop changed, from 6 feet to 4 feet 6 inches. In order for this alteration the ridges were ploughed down, and the partitions ploughed across the ridges for making them level, and then the next ridges were laid out the same way as the former, but narrower, and the double rows drilled on their tops—of consequence there must be some rows standing on every part of the ground, both on the former partitions and the intervals. Notwithstanding this, there was no manner of difference in the goodness of the rows, and the whole field was in every part of it equal, and the best

I believe

I believe that ever grew on it. It has now the 13th crop likely to be good." He advises making trial of single rows with intervals the same distance as those with partitions, and says, "I am now making trials in order to know how much a single row of white cone wheat will exceed half a double one," and adds afterwards, "I missed making my proposed experiments for it, by ploughing out one of the double rows in several places, but in the hurry of harvest they were cut together with the rest without making any trial, as should have been made, if my illness had not prevented my attendance in the field, at the time of reaping."

"Some think that ploughing so near the rows hurts the plants by breaking the roots; Dr. Fordyce in his *Elements of Agriculture* says, cutting the roots makes them branch more. Unless there be a number of fibres in the roots, the plants will seldom flourish, in as much as a sufficient quantity of nourishment cannot be absorbed, more numerous fibres may be made to break out by cutting the fibres. Roots push forwards with considerable force, a sufficient resistance stops them, and makes them branch out laterally. If the resistance from the soil be too great, they break out into a vast number of branches too weak to support the plants; and if too little, run out into long fibres, having too few ends or mouths to absorb sufficient nourishment. It is found by experience, that the crops are improved by hoeings near the rows, particularly at the last hoeings from the rows, before blossoming, and that the wheat fills and ripens better by hoeing at that time."

In all these operations there is nothing difficult for a ploughman accustomed to use a plough without wheels. The forming the ridges is the same, and the hoeings are performed in the same manner; there is no difficulty or attention required, but in ploughing the rows straight, and hoeing the intervals clean; even that

that will require little, as, after the horses or cattle have been accustomed to it one week, they will keep their line; and I have known common ploughmen execute all the operations well in a few days.

There are no new, or expensive instruments, only the drill plough, which now is more used and familiar to ploughmen. This requires no nicety of knowledge, only to observe that the seed drop properly, and to supply feed when necessary.



OF HOEING.

MR, TULL says, "Hoeing differs from common tillage, and is more beneficial. When land is made fine before sowing, as soon as the ploughman has done, the soil begins to undo his labours: The broken parts coalesce and unite by degrees, the consequence of which is, that as the plants grow up and require an increase of food, they have less when they have need of more. There is no doubt but one third part of the nourishment raised by dung and tillage, given to plants or corn at proper seasons, proportioned to the different stages of their growth, would be more beneficial to a crop, than the whole applied at the time of sowing. Hoeing keeps plants moist in dry weather—they are better nourished by it, and require less moisture. Deep, or horse-hoeing procures moisture to the roots from dews which are absorbed in proportion to the fineness of the soil, and the quantity

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that

that is made so fine. Hard ground, when thoroughly soaked with rain, will continue wet longer than fine tilled ground. Fine ground is not so long wet after rain as hard ; and dews never suffer it to be too dry. This appears by the plants which flourish and grow strong in fine ground, whilst those in hard ground are starved, except such of them as stand near enough to soft or hoed earth for the roots to borrow moisture and nourishment from it.

Mr. Tull says, "When wheat is drilled late in poor land, so that in the spring the young plants look all yellow ; let your hoe-plough make a crooked line like an indenture on a side of a straight row of this poor wheat, turn a furrow from it, and in a short time you will see all these yellow plants that are contiguous to this furrow change their colour gradually, as they stand nearer, or farther from it, and the other rows which have no furrow near them, continue yellow after all this row is become green and flourishing."

"The utility of hoeing," Mr. Tull says, "was suggested to him by observing the mode of tillage practised in vineyards : for the highest and lowest vineyards, he says, are hoed by the plough, first the high vineyards, where the vines grow upon great trees, as elms, and these are constantly kept in tillage, and produce good crops of corn, besides what the trees yield, and also the great and constant produce of the vine is owing to this sort of hoe tillage. Because, neither in the meadows, nor pasture grounds can vines be made to prosper though the land be richer and have a less crop of grass taken from it, than the arable has of corn. The low vineyards are hoed by the plough, and are constantly ploughed in the proper season. These have no other assistance but hoeing, because their heads and roots are so near to each other, that dung would spoil the taste of the wine they produce. All vineyards must be hoed, or else

else they would produce nothing of value. From these I took my *vineyard* scheme, observing that indifferent land produced an annual crop of grapes and wood without dung, although there is annually carried off an acre of vineyard as much in substance, as is carried off in the crop of an acre of corn; and yet the vineyard soil is never impoverished, unless the hoeing culture be denied it. But a few annual crops of wheat without dung will impoverish it.—I cannot find in theory, or practice any other good reason for this difference, except, that the vineyard soil is more pulverized by the hoeing, and not exhausted by more than a competent quantity of plants. After my return to England, having land coming into my hands, I improved these hints by observing that the same vineyard tillage bestowed on potatoes and turnips had the same effect on them as it had on the vines.

“ One of these observations that put me upon trials of wide intervals, and horse-hoing, was the following: One half of a poorish field was sown with barley, and the other half drilled with turnips; the rows were 30 inches asunder, at the proper season, were twice horse-hoed with a sort of horse-hoe for that purpose.

“ The drill beginning next to the barley left an interval of 30 inches between the first row of barley and the turnips. This interval between the barley and the turnips had the same hoeing as the rest, and had this effect on the broad row of barley next it; that each plant had many stalks. It was a very deep flourishing colour; the ears were very long, and in all respects the barley was as good, as if it had been produced by rich land. The next row of barley had some little benefit on the side next the strong row. But all the rest of the barley, either by the late sowing of it, the poverty of the soil (this not being in any manner dunged) or by the coldness of the land,

or coldness of the summer, though pretty free from weeds, was exceedingly poor, yellow, low and thin, and the ears short and small. This confirmed me in the principles which I had formed to myself, and my practice ever since hath been a further confirmation to me of the truth of the same principles.

“ This accidental observation was sufficient to demonstrate the efficacy of deep hoeing, which I look upon as synonymous with horse-hoeing—I immediately set about contriving my Limer horse-hoe.

“ The Michaelmas following I began my present horse-hoeing scheme, which has never yet deceived my expectations.

“ The practice of the scheme proves the advantage of deep hoeing by the ends of the ridges and intervals; for there while the drawing cattle go on the head land that is higher, the furrows are shallower, and the corn of the rows is always there visibly poorer in proportion to the shallowness.

About 1701, when he had contrived the drill for saintfoin, he used it also for wheat. Drilling rows at a foot distance with one bushel to an acre—the hand-hoeing cost from half a crown to four shillings an acre. This turned out well as it brought as good a crop on barley stubble as that sown the common way on summer fallow, whereas that sown the common way on barley stubble entirely failed. It was so great an improvement to the land, that when one part of a whitish strong ground of equal goodness was dunged and sown in the common manner, and the other part was drilled and hoed without dung; the hoed part not only produced the best crop, but the next year the whole being fallowed by a tenant and sown alike, the hoed part yielded so much a better crop of wheat than the dunged part, that strangers would have believed by looking at it, that part to have been dunged which was not; and that part not to have been dunged which really was.”

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The utility of hoeing is so obviously deducible from the principles already laid down, and may be so easily seen by almost every farmer, from his own practice, in some shape or other, and will appear so frequently in the course of the following chapter, that it is unnecessary to accumulate proofs under this general head.



CHAP. IX.

OF HORSE-HOEING.

HOEING may be divided into two sorts,—*hand-hoeing*, and *deep or horse-hoeing*. Of these, by the testimony of the most respectable authorities, the latter will be found to be greatly preferable.

In hand-hoeing there is always less seed, and a greater crop than in the common husbandry. Yet the rows must be much nearer than in the horse-hoeing, because the earth moved by the hand-hoe is many times less than that moved by the horse-hoe. And if the spaces, or intervals where the hand hoe only scratches a little of the surface, should be wide, they would be so hard and stale underneath, that annual plants would never be able to run through them.

To form the ridges at first of a proper breadth and straight, it may be done with poles to direct the ploughman, or when the old ridges are ploughed and level, a pair of wheels may be placed upon an axle at the distance the ridges are proposed; or the drill for drilling ridges, (as some are made for the wheels to go in the furrow.) Taking this over the ground, the wheels will mark out the ridge for the ploughman. When once formed and drilled, the stubble directs the ploughman the next time.

Mr. Tull, when he drilled 6 feet ridges, says, “ A 6 feet ridge contains eight furrows in plain ploughing, but we plough a 6 feet ridge at 4 furrows, because there are two furrows covered in the middle of it, and one on each side of it lies open. Now what we call one hoeing, is only two furrows of this ridge, which

which is equal to a fourth part of one plain ploughing; so that hoeing 4 acres requires an equal number of furrows, with 1 acre that is ploughed plain.

"I cannot prescribe precisely the most proper width of the interval, because they should be different in different circumstances. There must be a competent quantity of earth in them to be pulverized, and the richer the soil, the less will suffice. Never let the intervals be too wide to be horse-hoed at 2 furrows, without leaving any part unploughed in the middle of them, when the furrows are turned to the row.—Some ploughmen can plough a wider furrow than others that do not so well understand setting the hoe-plough.

"If for constant annual crops you make fewer than 11 ridges on 4 perches breadth, you increase the expence of hoeing, because 4 furrows will not hoe one of these intervals clean." By this Mr. Tull's hoe-plough must have ploughed very large furrows in hoeing, as, with 3 rows of 7 inches each, and 2 on the outside of the partitions is 18, and there remains of interval in a 6 feet ridge 54 inches to be hoed; to hoe this at 4 furrows, they must be very large; even with ridges, as by his last method of 14 in the breadth of an acre, it requires 4 large furrows to plough the intervals clean, as the breadth of the ridges is 56 inches, and in 10 inch partitions, with 2 on the outside, making together 14 inches, leaves 42 to be horse-hoed by 4 furrows to and from the rows, which requires $10\frac{1}{2}$ inches for each.

This a Rotheram or patent plough (which are commonly used for hoeing) will not plough clean at 4 furrows, so as to leave none of the earth unmoved, as they take a furrow of only 9 inches when held upright as they should be, allowing the 2 hollow furrows in the middle to be 18 inches, there remains 24 to be ploughed, which is 12 on each side.

And

And as the 2 first furrows from the rows take only 9 inches each or 18, this leaves 3 on each side unmoved, either next the hollow furrows, or next the slip of earth near the rows : if this last, it leaves too much firm earth next the rows, that would not be so well pulverized, as by the plough : if left next the hollow furrow, when the small ridge is split to be laid to the rows, as they move only what was laid there. The 3 inches unmoved at the first hoeing still remain so, or to remove this, some earth must be left between the furrows, at splitting the small ridge.

If left next the hollow furrows, this would hurt the succeeding crop which is sown there at 10 or 12 inches, as this hard earth would prevent the tender roots from entering the pulverized ground.

Therefore, when a plough of this size is used for hoeing, it would be proper to make the ridges only 4 feet 6 inches broad, with partitions of 12 inches, and 3 inches to be left on the outside, to be hand-hoed, which is 18. By this the 36 remaining would be clean ploughed with 4 furrows, without leaving any earth unmoved, which is two thirds of the ridge that is horse-hoed. This is $14\frac{2}{3}$ ridges in breadth of an acre.

Some who wish for more plants, make the ridges only 4 feet broad, with the partitions only 6 inches, and 3 on the outside. By this the intervals of 3 feet are as clean ploughed as the other with 4 furrows ; this is three-fourths of the ridge that is horse-hoed, and one fourth hand-hoed, and is $16\frac{1}{2}$ ridges in breadth of the acre ; but as the partitions are narrower, they cannot be so deep hoed as the other ; this will be some detriment to the plants.

Mr. Tull directs, "That when going very near the young plants the first or second time, which when dry and fine is apt to run over to the left of the plough. This we can in a great measure prevent by nailing with 3 or 4 nails, a very thin piece of board

to the sheat with one corner as low as the sheat, and the other lower corner bearing on the back of the coulter, on its left side, a little higher than the surface of the earth. Its fore-end is tied on to the coulter by a leathern thong passing through a hole near the end of the board. The lower edge of the board must not come lower than just level with the surface of the ground, before it is raised by the share.

This I have used with success, by making two small holes in the coulter, and placing two small hooks in the forepart of this board, which go into those holes of the coulter; and on the other side, two small pins which go into the forepart of the plough. Mr. Tull says, "Except in this case, we never use a board, the earth running over to the left side being often advantageous, as this earth helps to mend such places where the earth was not thrown up close enough to the rows."

Mr. Tull says: "The breadth of the ridges being diminished, occasioned somewhat more plough-work than formerly. But the profit of this increased labour is more than double the expence of it. It is better to make 15 ridges to an acre, than leave any earth unmoved by the hoe-plough, in the middle of the intervals; but when ploughmen, by practice, understand well how to use the hoe-plough, they will plough the intervals clean, though the ridges are only 14 on an acre."

When the ridges are formed, they may be harrowed before drilling, with two light harrows, which should be fixed together by a pole, and placed level, that each may go upon the top of a ridge, and the horse in the furrow between them.

The first hoeing is performed by turning a furrow from the row. This makes a small ridge in the middle of the interval, where the hollow furrows were left at forming the ridges: this should be near the rows, and deep. This hoeing should be before winter, and as soon as the wheat is grown, so as to distinguish

tinguish the rows, where using the plate of iron afterwards mentioned (on the plough) prevents the rows being buried by the earth falling on them; this hoeing keeps the wheat dry in winter.

The second hoeing is in spring, after the frost is over, by turning back the earth of the small ridge to the rows at two furrows. These should lay the earth as near the rows as can be, without covering them. In doing this the ploughman should attend to ploughing up the earth properly to the rows. If he should not clear out all the earth, going once up every interval, with a double mould board, will clean it out.

If the first hoeing has not been deep, and near to the rows, the second should be by going in the same furrow as the first, but deeper and nearer the rows.—And then, the third furrow only lays the earth to the rows.

The fourth should be given before the wheat blossoms. The hoeing at this time is very necessary, whether it be to or from the rows, as it gives fresh nourishment to the plants, whereby the ears become fuller and larger. Mr. Tull directs only four hoeings, twice from the rows, and twice to them; but when the second is also from the row, there must be a fifth after the wheat blossoms is over. At this time the earth is ploughed to the rows.

For making ridges for a second crop, Mr. Tull directs to turn two large furrows into the interval, going as near the stubble as convenient. If the trench be not deep enough, go first in the middle of it with one furrow, which with two more from the ridges, will be three furrows on each interval: continue thus forming these furrows, while the weather is dry.—The other furrow with the stubble may be ploughed wetter.

By Mr. Tull's manner of horse-hoeing, there is much more surface exposed, than by plain ploughing.
First

First, by the deep hollow in the middle of the interval, at forming the ridges.

Next, when the small ridges are formed in the hollow furrows or trench, if the intervals are supposed 36 inches, if the plough goes 8 inches deep, the two side cuts are 16; the bottom, where the sole of the plough went 18; and the sides of the ridge at least 14 inches each. By this 58 inches in place of 36, near one half more, is exposed to the air and atmosphere. Mr. Tull directs pulverizing the soil a good depth, where the staple will allow it; as the deeper it is pulverized, and the finer it is made, the deeper the air and dews penetrate. He mentions the experiment of digging a hole, and filling it with earth well pulverized; this will be found moist at the bottom, when the bottom of a furrow, of a few inches, will be found quite dry; therefore the roots of the one have moisture, and the others have none: but it is not pulverizing only that he directs, but exposure to the atmosphere, to receive the benefit from it, which sinks deeper in pulverized than in hard stale ground.

Hand-hoes, shims, and miners may answer to destroy weeds, but these going only one inch or two deep, have not the same effect; as the ground below remains nearly as hard as that whereon a crop stood, and must require much ploughing to put it in the order a farmer would require for wheat or barley.

Mr. Tull, in many parts of his works, shews the advantage of deep hoeing to pulverize the soil; and how much superior horse-hoeing is to hand-hoeing, which only goes a few inches deep. In his Addenda he says, "I was desired to take an exact account of the produce of a single land of hand-hoed wheat, and an acre in the middle of a field of 25 acres of horse-hoed, in order to know the different quantities produced by each. The first was in a common field planted upon the level with the same drill that planted the other, whereby there was a space of 10 inches

tween the two rows, and a space of 18 inches between this and the next row, so that each row had a space of 14 inches of surface for the roots to spread in. It was hand-hoed very well, and the land had not been dunged in any manner since the year 1719.

“ This crop was reaped very low, and threshed out immediately, and produced $11\frac{1}{2}$ bushels, the measure of the land being 52 perches. The produce is at the rate of 36 bushels 6 gallons* per acre. The lands adjoining to it, of the same goodness, were judged by all gentlemen and farmers, who viewed them not to have above half the wheat on them, that this had, perch for perch : and yet there was no difference in the management, except this being regularly planted and hand-hoed without dung ; and the other sown at random and dunged, (as they always are once in three years) The fallowings and ploughings of both were the same.”

“ As to the acre of horse-hoed wheat, it measured 8 perches broad and 20 long, which is equal to 66 feet in breadth, and 660 in length, the statute measure of an acre. The crop being laid by itself, was after some time threshed, and the produce 29 bushels 6 gallons† of clean wheat. Before it was threshed, it was diminished by cows that found a hole betwixt the boards of the barn, and pulled out some of it, and the poultry eat more ; but the most extraordinary thing was, it being cut by bad reapers, who cut it so high, that many of the ears, which by their great weight bent low, were cut off. I believe that if it had been well reaped, as most of the rest of my wheat was, there would have been 32 bushels received from this acre.

“ As to the difference of profit of the hand-hoed

* As his measure is 9 gallons per bushel ; this is 40 bushels three pecks.

† As his measure was 9 gallons per bushel, this is 33 bushels 1 gallon, Winchester measure.

and

and horse-hoed crops, it will, upon examination, appear to be contrary to the opinion of the vulgar; the soil of the hand hoed being at least as good as the other. Let us suppose them equal, and also the expence to be equal, though that of the horse-hoed is the least. The hand-hoed was planted on a fallow, but the other had a good crop of wheat the preceding year, drilled in double rows; and the year before that had a crop of barley drilled in treble rows, the ridges always the same breadth; all these were horse-hoed: but the year before the first of these, it had a crop of sown black oats, so that there were four successive crops without a fallow or dung, and there is now growing a fifth crop, being wheat, likely to be much greater than any of the preceding." Therefore here being two crops of wheat for one; the profit of the horse-hoed is almost double that of the hand-hoed; the hand-hoed has but one crop of wheat in three years, and one of barley, which is scarce half the value of a crop of wheat, and the expence of the three years being in seed, tillage, &c. as much as the three crops of wheat, the profit of the horse-hoed will be more than double that of the hand-hoed.

This, I think, is a strong proof of the efficacy of deep horse-hoeing without a fallow; as, in this case, it caused a double row to produce as much wheat as two double rows of the shallow hoed with a fallow on an equal quantity of ground: an effect which could not have been produced, unless each row of the lesser number yielded more or larger ears, or both, than the greater number: neither could this be the case, if the roots did not take the greatest part of their nourishment from the pulverized intervals; considering that the rows having had no fallow, must, without the deep pulverizations, have produced much fewer and smaller ears than an equal number of rows that had the benefit of a fallow: vain therefore is the opinion of those, who say the roots of wheat do not reach further

further than two or three inches from the stalks, for if they did not, the horse-hoed rows could have little or no nourishment from the pulverization of the intervals. If they did not enter them, they then must have produced less than an equal number of rows of the hand-hoed (that had a fallow) did, instead of almost twice as much.

“As to the question, how many times wheat is to be hoed in summer, it depends on circumstances and the condition of the ground; but, be the season as it will, never suffer weeds to grow high, nor any unmoved earth to lay in the intervals long enough to turn hard.

“It is not often we hoe above four times, when the *second* hoeing goes in the furrow of the first, to make it deeper; the *third* fills up this furrow, and the *fourth* turns this furrow from the rows into the intervals.”

He says, “The rows from which the earth is hoed in the beginning of winter, and left bare till the spring, one would think should suffer by the frost coming near them, but it is quite contrary, for where the hoe has gone nearest the row, its plants thrive best. The earth which the frost had pulverized being within reach of the young roots on that side of the row, nourishes them at first, and when they grow larger in the spring, the earth from the middle of the intervals is thrown into them.”

He says, “Roots broken by the hoe-plough, is no damage, for they send out a greater number of roots than before; and these young multiplied roots are fuller of lacteal mouths than the older ones, which makes it no wonder that plants should thrive faster by having some of the roots broken by the hoe: for as roots do not enter every pore of the earth, but miss part of the pasture which is left unexhausted; so when new roots strike from the broken parts of the old, they meet with that pasture their predecessors missed. Besides that new pasture, which the hoe raises for them,
and

those roots which the hoe pulls out without breaking, and covers again, are turned into fresh pasture; altogether invigorates the plants.

Dr. FORDYCE, in his Elements of Agriculture says, "The advantages of drilling are:

" 1st. Giving an opportunity of destroying weeds.

" 2d. Of cutting the fibres of the roots, so as to make them branch out again.

" 3d. Of loosening the earth about the roots.

" 4th. Of throwing the earth on the stems, so as to make fresh roots break out.

" 5th. Saving superfluous seed.

" 6th. Sowing the ground more equally.

" 7th. Giving a free passage to the air."

" Most plants that are used in agriculture, which do not branch out at the sides above ground, as all corn and grass do, may be made to branch out below.—Plants by being too close rob one another of what they receive from above, air, sun, dews, rain, &c.

" Of the effects that attend the thorough ploughing and pulverizing the soil, there are two most certain: If there is any poisonous quality in the soil from metals or sulphur, you destroy them by turning up the soil to the air, and you open a way for the fibres of the plants to go in quest of their food, and thereby render them strong and vigorous."

Some think where there are few weeds, a saving is made by giving one hoeing less. Mr. Tull gives an instance of the bad effects of this. He says, "The worst error, I apprehend, the beginner will be liable to, is to expect the benefit of pulverization, where his land is not pulverized. I had this year, in the middle of a field of wheat, about two or three acres, the earth of whose partitions missed one of the hoeings in the preceding summer; the colour of the wheat was plainly distinguished from that of the wheat on both sides of it, at half a mile distance, in the spring, and was not above half the crop at harvest."

But

“ But if the rest of the piece had not had a hoeing more than this had, the whole then being alike poor, it would not so plainly have appeared, that the poverty of it was want of hoeing.”

Mr. Millar, whose knowledge of plants is undoubted, says: “ Mr. Tull’s deep or horse-hoeing husbandry has been almost universally rejected by farmers, it is so opposite to their accustomed practice; but notwithstanding it is much to be wished that this new husbandry might be universally practised. For some few, who have made trials of it, have found their crops answer much better than by the common husbandry. I have been informed by persons of great credit, that on good land that was drilled and horse-hoed, they had twelve quarters from one acre of land. Deep ploughing, where the staple of the ground is deep enough to admit of it, will be of great service to the corn, for the small fibres of the roots, which are the mouths that supply the nourishment, extend themselves very deep in the ground. I have traced many of them upwards of three feet deep, and believe they spread much further, where the ground is light. It is therefore of great advantage to have the ground stirred and loosened to a proper depth; for by so doing, their roots will find a supply of pasture for the nourishment and augmentation of the ears at the time they are forming, when it is most required. If the ground is ploughed shallow, the roots will have extended themselves to that depth by spring, so that when the nourishment is wanted to supply the stalks, the roots are flinted by the hardness of the soil which they cannot penetrate. When this is the case, the colour of the blades is frequently seen to change in April, and they seldom recover their verdure again. When this happens, the stalks are always weakened in proportion to the decay of the blades; for it is well known, from long experience, that the leaves or blades of corn are necessary to draw in nourishment
from

from the air and dews for the increase of the stalks and ears."

These extracts are sufficient to shew that *horse-hoeing* is greatly preferable to hand-hoeing, and the comparative advantages of the two modes may be more fully seen under the heads, *Drilling*, *Intervals*, and *Produce*.



CHAP. X.

EXPENCES.

THE farmers believed, that the expences of the drill husbandry were more than that of the broadcast, "From the frequent horse and hand-hoeing." Mr. Tull says, "I began my horse-hoeing scheme, first with double rows, but then they were different from what they are now, for the first had their partitions unequal, being the parting space, thereby less proper for hand-hoeing; the intervals were also too narrow for constant crops."—For some time he practised drilling three or more rows; but finding the middle row not equal to the outside rows, he drilled only two, (as it is easier cleaned from weeds) and the hand-hoeing cannot give so much nourishment or pulverize so much earth in the two 7 inch partitions, than from 1 in 10; and the ridge must be twice as deep of the mould for the triple rows, as for the double, or else the middle row will be very weak and poor, and the whole will be more exhausted than

P

by

by an equal product produced by strong plants. He afterwards from experience reduced his ridges to 4 feet $8\frac{1}{2}$ inches, or 14 in the breadth of an acre, or 4 perches; upon this he drilled 2 rows at 10 inches, and hoed only 4 times.

Mr. Tull employed oxen, which he fed upon lucern. In his calculation of expences, when he hoed only 4 times, he states 1 ploughing to form the ridges, and 4 hoeings equal to 2 plain ploughings in the whole with oxen, only 4s.

If it is done with horses, which is more expensive, 4s. each, or 8s. for ploughing and hoeing. By working with oxen he states,

	s.	d.
Ploughing and hoeing, -	4	6
Seed, 3 pecks - - -	2	3
Drilling - - -	0	6
Weeding - - -	0	6
Brining and liming - -	0	3
Reaping - - -	2	6
	10	6

Mr. Crack states his expence, harvest home, at 1l. 1s. which is only 17s. per English acre. He drilled little short of a Winchester bushel to the Scot's acre ($1\frac{1}{4}$ acre English). "Though my soil is stiff and heavy, I used only 2 horses to the single hoe. The single hoe hoes $2\frac{1}{2}$ Scots acres per day, above $3\frac{1}{2}$ acres English."

Sir Digby Legard says, "After the first year, when the land is reduced into fine order, one horse is generally sufficient to turn a furrow to and from the rows; and as a man and horse can with ease horse-hoe 4 acres in a day, it cannot cost more than 1s. to hoe an acre, even including the repairs of the instruments, nor are more than 4 hoeings commonly required; so if we reckon 4s. for ploughing the ground once to form the

the ridges; 4s. for horse-hoeing, 2s. 6d. for hand-hoeing; 2s. weeding, and for drilling 6d.; 13s. is the whole expence of managing an acre, in the new husbandry, and 3s. 9d. for feed, makes the whole expence 16s. 9d. Such therefore being the case with which this celebrated method is performed, so great the improvement of the land by it, and such the extraordinary effects produced by merely stirring the earth, one would think every husbandman should be induced to give it a fair and candid trial."

Sir Digby Legard, although he states only one ploughing per acre to form the ridges, and 4 horse-hoeings; in the comparison he makes with the Norfolk course of broadcast, states twice ploughing before sowing, and 3 hoeings, and these with 1 horse. He states the expence at 17s. 6½d. with wheat, and with barley drilled 16s. 0½d. Several writers impute his crops being so much smaller than Mr. Tull's, (upon land of like quality, being light and dry) to his hoeing with one horse, and with shims and miners, and hoeing only 3 times, in place of using a plough with 2 horses and deep hoeing.

The expences of cultivation differ in different places, according to the soil. It is plain it must be so, as a strong clay requires more strength than loam, or light soil; but it is not from that cause alone, that the expences are different, but many others, as the plenty of labourers, price of labour, cheapness of living, &c. These must needs vary the farming expences; but neither are all these circumstances united the only causes of difference in the expence: custom more generally regulates many places where they use oxen, there is often 6 oxen and 2 horses where they plough only a few inches deep, and in soil, not clay; and I have been informed, that in many places a ploughman would not plough with fewer than 10 oxen, any more than a coachman accustomed formerly to drive 6 horses, would drive a cart: and many places round

London, in light garden ground 5 horses are commonly used under pretence of ploughing deeper.

In many places the price of a first ploughing is from 6 to 10s. an acre, in others only 4s.

But in ground, in good order, and moderately pulverized by constant tillage, more than 2 horses are not necessary, and the acre may be ploughed for 4s.

In horse-hoeing, as it is pulverized and kept fine by frequent hoeings, and never allowed to be stale and hard, even after a crop, more than 2 horses can never be necessary.

The other farming expences must be regulated by the custom and prices of the country.

Thus the expences must be different in different places.

In a course of four years of barley, turnips, clover and wheat, shall state some others in the same manner :

	l.	s.	d.
Sir Digby Legard's - - -	9	7	6
Is per year - - -	2	6	10½
Dr. Hunter's 4 years - - -	13	19	0
Is per year - - -	3	9	9
Mr. Young's - - -	10	5	11
Is per year - - -	2	11	5¾

In the 13th volume of Annals of Agriculture, Mr. William Pitt states the Norfolk course with harvesting and tythe	}	11	2	0
Is per year - - -		2	15	6

After clover, wheat, including all expences - - -	}	5	18	0
Fallow, wheat - - -		8	4	0
Barley after turnips - - -		3	4	6
Mr. Young states fallow wheat - - -		6	6	0
Fallow barley - - -		6	16	1
Barley after turnips - - -		3	5	6

In

In ploughing the ridges to form them, I shall state the hiring price of 4s. per acre. These ridges are ploughed plain at three bouts: and Mr. Tull says, his 6 feet ridges are ploughed at 4 furrows; in plain ploughing it takes 8. A ridge at 4 feet 8 inches would require 6 furrows in plain ploughing; but in forming new ridges they are formed at 4. This is one third less than plain ploughing.

HARROWING.—As there are 14 ridges in the breadth of an acre, or 66 feet by Mr. Tull's latest practice, 2 light harrows should be fixed together by a pole, to go upon the top of the 2 ridges, and the horses should walk in the furrow between them; as 2 ridges are harrowed at once, the horses walking on the hollow furrows seven-lengths of the ridge or $3\frac{1}{2}$ bouts harrows an acre. Having often counted the time of a plough making a bout of 220 yards, when the horses were walking slow, I found they made a bout in 8 minutes, but shall allow 10. This for $3\frac{1}{2}$ bouts is 35 minutes to harrow an acre: at the above rate 14 acres are harrowed in 8 hours and 10 minutes, and the horses walk at the rate of $1\frac{1}{2}$ mile per hour; but allowing that they only harrow 12 acres at the rate of 4s. per day, it is 4d. per acre.

DRILLING.—With a double drill that sows 2 ridges, 1 man, 1 horse, and a boy at 3s. drill 12 acres, which is 3d. and with a single drill that sows 6 acres, is 6d. per acre.

In **HORSE-HOEING**, as they make one bout in 10 minutes, and there are 14 bouts an acre, it requires 2 hours 20 minutes, and 4 acres in 9 hours 20 minutes, which at 4s. per day, is 1s. per acre. But allowing only 3, is 1s. 4d. and 4 hoeings 5s. 4d. With 2 horses and 1 man, it should cost but 1s. per acre.

SEED.—Mr. Tull and others drilled 3 pecks per acre, which at 5s. per bushel is 3s. 9d.

HAND-HOEING.—Mr. Tull paid 2d. for hoeing 30 roods, or 165 yards, which is 1s. 6d. per acre; and
now

now they drill equidistant rows at 9 inches, the expence of hoeing is only 1s. 6d. per acre; and where the partitions are horse-hoed with shims, the hand-hoeing the rows is done for less. With Mr. Cook's machine-hoe for hoeing the equidistant rows, Mr. Boot, in his account of his Comparison says, he hoed 10 acres in a day. This at 4s. is near 5d. per acre.

There is no occasion for cutting stubble, where the practice is to reap low, neither is there occasion to water furrows when sown early, as the first furrows from the rows, before winter, keep the wheat dry, and when ploughed to the rows, the hollow furrows have the same effects.

DRILLING EXPENCES.

	s.	d.
2 Bouts to form the ridge, when in ridges -	2	8
3 Pecks of wheat - - -	3	9
Driling at 6d. per acre per day -	0	8
4 Horse-hoeings - - -	5	0
Hand-hoeing rows - - -	4	0
	16	1

In Mr. Young's Experimental Agriculture, although he states the expence of successive crops in these experiments on an average of ten experiments, at 4l. 2s. 4d. it arises to that amount from some being higher from hoeing and other expences; but some are only 2l. 19s. 1d. including rent and harvest.— But I shall state one.

If from the subsequent statement of Mr. Young, we deduct the unnecessary expences and overcharge, the profit will appear to be 2l. 2s. 5d.

Cutting

	Mr. Young's State of Expences.			Necessary drilling Expences.			Difference.		
	l.	s.	d.	l.	s.	d.	l.	s.	d.
Cutting stubble	0	5	0	0	0	0	0	5	0
2 Ploughings	0	4	0	0	2	8	0	1	4
Harrowing	0	0	4	0	0	0	0	0	4
Drilling -	0	0	7	0	0	8	0	0	0
Seed - - -	0	7	6	0	3	9	0	3	9
4 Horse-hoeings	0	6	8	0	5	0	0	1	8
2 Hand-hoeings	0	7	6	0	4	0	0	3	6
	1	11	7	0	16	1	1	5	7
Deduct	0	15	7	unnecessary addition of expence.					
	0	16	0						
	1	7	7	Harvest expences.					
	2	3	7						

Two quarters at 1l. 16s. 3 12 0
 Straw 0 14 0

Produce 4 6 0
 Expences 2 3 7
 Profit 2 2 5

By thus allowing these expences, the whole expence of an acre drilled should not exceed the value of 8 bushels of wheat, and supposing the produce so low as 2 quarters or 16 bushels, at only 1l. 16s. per quarter, with the value of the straw, the profit should be at least 2l. 2s. 5d.

In experimental agriculture the expence of horses is stated from 10l. to 14l. which is less than 1s. per day.

Another instance of the expence of drilling appears when we compare the expences of keeping horses, with the quantity of land they cultivate, I shall suppose the horses cost each 15l. a year, which is less than 1s. per day for the working days, and the ploughman 12l. a year, or 9½d. a day for the working days.

The

	l.	s.	d.
The horses 30l. the ploughman 12l. is	-	42	0 0

	PER ACRE.		
This for 80 acres, the quantity managed by a plough in the drill husbandry, is, including harvesting and carrying out	-	-	-
Seed, 3 pecks per acre	-	-	-
Hand-hoeing partitions	-	-	-
		0	10 6
		0	3 9
		0	4 0
		0	18 3

As, in addition to this labour, some assistance may be necessary to this at seed time, and to forming and drilling, suppose an additional plough employed for 3 months; the expence of this is 10l. 10s.

After the wheat is sown, the ploughs can labour, say 20 acres of spring crops, and 20 in grass, and I shall suppose the profit of that only to be 1l. per acre, or even one half; this would pay the additional expence, and allow for incidents. For this cattle may be purchased in harvest; and these after wheat seed season may be fed in the straw-yard, and sold in the summer from the grass with profit. As the quantity of grass mentioned is more than necessary for the horses, or if a few acres of potatoes were cultivated by horse-hoeing, it would be found profitable for feeding the cattle, as well as a great saving of corn.

The Rev. Mr. Dean sowed three pecks per acre; his drills were made by Mr. Tull's directions. The expence of hoeing is not mentioned.

Mr. Cox, near Lymington, who obtained the gold medal from the Society of Arts, for his comparative experiments between wheat drilled in rows at one foot, and broadcast, states the following:

Upon 6 acres drilled were sown 6 bushels of wheat, 2 acres were manured with chalk, the rest had no manure.

The

	l.	s.	d.
The expence of the drilled, per acre, was	1	9	2
And the produce was 23 bushels.			
The expence of the broadcast	1	15	0
And the produce, 19 bushels 2 pecks.			

In the Museum Rusticum, vol. IV. Mr. E. S. states a comparison of drilled with a Mr. Y's state of 20 acres broadcast for 9 years. In that he states 2 ploughings and 6 hoeings, according to Mr. Tull's first practice upon 6 feet ridges, and where ploughing is at 4s. per acre, and rent 15s. Those who state the whole expences and profit of an acre from small experiments of a few roods, and calculate the proportion of an acre from that statement, can never be accurate. For a small experiment may be so carefully attended to, that not a single ear shall be left in the fields, or lost, which is far from the case in a large field, where the reapers are often very negligent, and the gleaners carry off a great deal; and in threshing a large field, there is often very great loss. On the other hand, in a small experiment, birds or accidents destroying a small part of it make a considerable difference in the calculation of an acre, or a field; but most of the statements above-mentioned, being taken from experiments made upon great quantities of land, are juster than those from small experiments.



C H A P. XI.

COMPARISONS.

IN the BROADCAST HUSBANDRY, the seed sown is $2\frac{1}{2}$ bushels per acre. If the produce is 20 bushels, this is only 8 after 1, if 24, it is $9\frac{1}{2}$ after 1.

If every grain were to produce one ear, that one ear would only produce 8 grains.

But on examining a BROADCAST crop, many of the grains produce two ears, and some more, where they have space; therefore a great deal of the seed is lost, and does not produce.

MR. MILLAR says, "if a field of corn sown in the common way is examined, they will find few roots, which have more than two or three stems, unless some few roots which have room to spread, upon which may be eight or ten stalks; but in a field of wheat, which had not a greater allowance than one bushel of corn to an acre, I have observed that the roots produced from 12 to 14 stalks."

MR. S. in the MUSEUM RUSTICUM, who examined the ears of the broadcast, states the produce of the ears, as hereafter mentioned, at an average of $15\frac{1}{2}$ grains per ear. If we calculate the ears at that produce, then nearly one half of the grain sown does not produce ears. If we suppose the produce 24 bushels, two fifths do not produce, or are destroyed, or the one bushel is lost.

In the DRILL husbandry, three pecks is the common quantity drilled upon ridges for horse-hoeing. This is less than one third of the seed sown broadcast, or nearly three pecks of seed saved. The ears are much larger when they have more space; and in good ground,

ground, upwards of 52 ears are produced per foot, and each ear in such ground has been found to produce 60 grains.

The old husbandry is different from the new; which is an improvement of it.

In the old, the whole of the ploughing and harrowing is done first, to reduce and prepare the ground for seed. When the ground is hard, the roots cannot penetrate, or extend to find proper nourishment without assistance.

When it is in that state, it does not allow the sun and air, and dew, and influence of the atmosphere to penetrate into the roots, and enrich the soil.

For this purpose it is ploughed, and made fine to a certain degree, and manured. The finer the ground is made, the more the fibres of the roots come into contact with the soil. For, suppose the earth were all in pieces of an inch square, there would be many intervals where the earth did not touch the roots, and if these squares were hard, it would not touch them but in some few places, and therefore could receive very little nourishment from that earth, though the grain extended its roots a great way; whereas if it were fine, the earth would cover the roots and touch them in every part, by which the plants would receive more nourishment by the roots extending 6 inches, than by extending 2 feet in the other. Hence, as the earth is the conveyer of the vegetable nourishment, roots receive more from ground made properly fine, than from ground not properly pulverized.

In the OLD HUSBANDRY the ground is seldom made so fine as to allow the roots to extend; as in the common courses there are not opportunities to do it, except when it is fallowed.

Besides, when land is not made fine, many of the weeds do not grow, and therefore cannot be destroyed until it is fallowed, and when made finer than ordi-

nary, for barley, or other crops, these weeds appear in abundance.

In many of the courses, the weeds, instead of being destroyed, are encouraged and encreased. As the ground is often worn out and exhausted by over cropping, it is then so hard and poor, that scarcely any thing will grow but weeds, which grow in abundance and multiply, and are ready to destroy any crop. The farmer is at the expence of bestowing cultivation and manure upon it; and in the old husbandry, the quantity of seed sown is three or four times more than necessary, and more than the ground in the situation it is in, can nourish and bring to perfection, were they all to grow. And the weeds exhaust the ground of more of the vegetable nourishment, than what, if properly applied, would be necessary to produce a good crop.

As wheat is the most valuable crop, most labour and expence are bestowed, in order to restore and enrich the ground, so as to be able to produce it. As this grain is to be longer maintained than spring-corn, it requires more nourishment; but as it has no assistance from seed time to harvest, the ground subsides, and then turns hard and solid, which prevents the roots from penetrating in quest of nourishment when they have the most occasion for it; that is, when going into ear.

In the BROADCAST culture, the earth is solid and hard after a crop, by being so long under it without any cultivation, and therefore requires more strength to plough it.

THE DRILL HUSBANDRY was proposed to remedy the defects of the old, by pulverizing the ground and making it fine, and keeping it so by frequent and deep horse-hoeing; in order to allow the roots freely to extend in quest of nourishment.

It was intended, by drilling the ground in rows, to allow it more space for receiving the benefit of the influence

influence of the atmosphere, dews and air; by means of horse-hoeing to the ground, and by exposure, to receive the benefit of those celestial influences, not only to assist the present crop, but to prepare it for the next.

By allowing more space to the seed: to sow no more than the ground can nourish and bring to maturity.

By hoeing, more effectually to destroy the weeds, and prevent them from depriving the grain of so much of the nourishment as it ought to have. The effect of this is plainly seen by examining a broadcast crop, where the ears are found much smaller, and the ground well stocked with weeds. This Mr. Tull mentions, and says, "when the broadcast farmers have done all they can, the pasture they raise is generally too little for the stock that is to be maintained upon it, and much the greater part of the plants are starved. As from 10 gallons of seed they sow ($2\frac{1}{2}$ bushels) upon an acre, they receive commonly no more than 20 bushels of wheat per acre, which is but an encrease of 8 for 1. They are obliged to sow a great quantity of seed, that the great number of plants may be the better able to contend with the weeds; and yet too often at harvest we see a great crop of weeds and little wheat."

The weeds are destroyed in the old husbandry only by fallows, or fallow crops. In this last, the superficial hand-hoeing is not so effectual, as deep horse-hoeing; and that is performed only once in the course. But in the drilled it is repeatedly horse-hoed several times every year by a plough.

In the drilled husbandry there is not above one third of the plants; and although it should produce as great a crop, or greater than the broadcast, the land is much less exhausted, as there are fewer plants, as the hoeing adds a fresh supply, and each grain is
allowed

allowed four times the space of earth, or surface, to grow upon.

Dung is not necessary where the ground is good, and made properly fine by the hoeing culture. Mr. Tull thus compares the situation of those who adopt his method with that of those who follow the old course; "We can hoe two furrows whereon the next crop is to stand, immediately when the crop is off.

" 2dly. We have no use for a fold, because our ground has annually a crop growing on it, and it must be a year, if we would fold it.

" 3dly. We can plow dry, and drill wet without any manner of inconvenience.

" 4thly. The broadcast farmer fears the weeds will grow and destroy his crop.—We hope they will grow; to the end we may destroy them.

" 5thly. We do not fear to plant, because we can help the staleness and hardness by hoeing.

6thly. We can plough our two furrows of every ridge dry, whereon the rows are to stand.—After finishing them, let the weather be wet or dry, we can plough the last two furrows.

" We can plough our two furrows in the fourth part of the time, they can plough their 8, which they must plough all dry on a 6 foot ridge, they cannot plough a part dry and a part wet, as we can.

" 7thly. We never plant our seed under furrow, but at a proper depth, and then there is no danger of burying it.

" 8thly. We not only plough a deep furrow; but also plough to the depth of two furrows, that is, we trench plough where the land will allow it, and we have the greatest conveniency imaginable for doing this, because there are two of our four furrows always lying open, and two furrows ploughed (one under the other) are as much more advantageous to a crop, as two bushels of oats are better than one for nourishing a horse.

9thly.

9thly. We raise a high ridge on the middle of each interval, and the furrows or trenches from whence the earth of these ridges were taken, serves to drain off the water from the wheat, which makes it drier than harrowed wheat."

In the horse-hoeing husbandry, repeated successive crops are obtained of wheat without manure, which cannot be obtained in the old husbandry with manure, and this with one ploughing and four hoeings.

Therefore the four hoeings producing successive crops without manure, (which cannot be done in the other, even with manure) shews clearly the superiority of ploughing or deep hoeing over manure, when so little as four hoeings, which is only equal to one common ploughing, produces such an effect.

Mr. Tull and others have made comparisons between the broadcast and drilled mode of agriculture for *one crop*; Mr. Tull used oxen for his tillage, fed upon lucern, which maintained them at a small expence; he states the expences with cattle, in the country where he lived, as follows:

BROADCAST.			DRILLED.			s. d.
2½ Bush. seed, at 3s	} l.	s. d.	Seed - - - -	} s. d.	s. d.	2 3
per bushel 7s. 6d.			Tillage if done by			8 0
Thrice ploughing and harrowing 16s.			horses			0 6
Weeding - - -	} 1	3 6	Drilling - - -	} 8 0	s. d.	0 6
Rent of a year's fallow			Weeding - - -			0 6
3 Load of dung, 11 10s			Uncovering - -			0 2
and cartage	} 2	10 0	Brining and liming	} 2 6	s. d.	0 1
Reaping and Harvest			Reaping - - -			2 6
		4 6				14 0
		<u>4 10 0</u>				

"To compare the profit we may proceed thus: the rent and expence of a drilled acre being 1l. and of a sowed acre 5l. one quarter of corn bears an equal proportion in profit to 1l. as five quarters produced

duced by the other, do to the 5l. The expence of a drilled acre is but the 9th part of the sown in the common manner.

In making comparifons between the broadcast and the drilled mode of cultivation, to reason from one crop is not a juft comparifon. For, although the broadcast may often produce a greater crop for one year, it may not be fo profitable for the courfe: nor indeed, all things confidered, for the year. The profit is not the quantity produced; but what is free after all expences.

The broadcast tillage is often fallowed and manured for wheat and barley. This is a confiderable expence, if ftated to that crop only: and as the advantage is felt by the encrease of the following crop, to ftate the expence of manure and fallow to the firft crop is not a fair mode of comparifon. A fallow, manured, is not lefs than from 4l. to 6l. To repay this alone would require a produce of from 16 to 24 bufhels of wheat. Whereas the total expence of the drilled tillage including rent, does not exceed the value of 8 bufhels, or 2l. And if the two acres were drilled, fhould produce 40 bufhels for the expence of 4l.

The broadcast produces but one crop of wheat in a courfe of feveral years, and the other crops are of much lefs value; whereas in the drilled and horfe-hoed there is a crop of wheat every year, which cannot be raifed in the broadcast, even with manure.

In Mr. Young's Tour through England, almoft the whole of the wheat is after fallow, and alfo manured; and in all this, there are $\frac{2}{3}$ that do not exceed 20 bufhels per acre.

The other $\frac{2}{3}$ are rich and high rented ground, and produce great crops. The average of the whole in the broadcast agriculture is 24 bufhels per acre. He mentions experiments of drilled crops, where the average was 25 bufhels.

To

To produce this average of 24 bushels in the broadcast, 2 acres are employed, the fallow is ploughed from 5 to 6 times, and exclusive of rent and harvest, is not less than from 4l. to 6l. per acre.

If two acres are drilled and horse-hoed, the expences as above are 2l. per acre, or 4l. for the two, and the produce 5 quarters or 10l.; and the expences of the other from 4l. to 6l. to produce 3 quarters or 6l.

	l.	s.	d.
The difference of profit of broadcast, produce } 3 quarters - - - - -	6	0	0
Expence - - - - -	4	0	0
Profit	2	0	0
Drilled two acres, 5 quarters produce - - -	10	0	0
Expence - - - - -	4	0	0
Profit	6	0	0
Deduct broadcast profit	2	0	0
Drilled superior - - -	4	0	0

Besides the difference of laying out so much for manure upon this crop, which may be employed to more profit to the farmer upon other ground.

Mr. Tull made many comparisons between broadcast and horse-hoeing, and says: "I have often weighed the produce off the same quantity of ground. (I allow two square yards of their crop, to one yard of my treble rows) of all sorts of sown wheat, both the best and worst, but never have found any of the *sown* equal to my broadcast." ("I am sorry that this farm whereon I have only practised horse-hoeing, being situated on a hill, consists of chalk on one side, and heath ground on the other, has been noted for the poorest and most shallow soil in the neighbourhood.

COMPARISONS OF HOEING AND BROADCAST.

A VERY intelligent and accurate farmer, a Mr. E. S. who has wrote several letters in the Museum Rusticum upon the drill husbandry, and shewn many mistakes and unjust accusations of some who wrote against the Tullian husbandry, in the third volume, mentions an experiment of the weight of wheat, and number of grains per ear; and weight of straw and chaff in the broadcast culture.

“ He took out some wheat from a sheaf, sorted it into four parcels, and weighed them separately, and the straw and chaff, and numbered the grains and ears.

	Ears.	Grains.	Per Ear.
Largest	250	5467	22
	500	8765	17½
	250	3545	14
	250	1622	6½
	1250	19399	60

Average of the whole of the ears is $15\frac{1}{2}$ grains per ear.

Twenty of the largest ears produced at a medium, 34 grains per ear, and 2 only produced 40 and 41.

The length of the ears was from $3\frac{1}{4}$ to $1\frac{1}{4}$ of an inch, the medium 2 inches. The weight of the crop, agreeably to the above reckoning; the same at 20 bushels is $22\frac{1}{2}$ Winchester, the total weight of the crop per acre.

WHEAT.			CHAFF.			STRAW.			TOTAL.		
cwt.	qr.	lb.	cwt.	qr.	lb.	cwt.	qr.	lb.	cwt.	qr.	lb.
12	2	0	3	1	23	13	1	7	29	1	2

From this he shews the uncertainty of calculating the amount of a crop from taking a small number of ears; and from the uncertainty of fixing on any size of ears that will give a just medium. He says, “ The disproportion in the number of small and large ears is very remarkable, as also in size: for if we calculate from the 20 largest, we shall find that 43 of them weighed

weighed as much as 288 small ones ; or 1 large one produced as much corn as 7 small ones. This great difference is not from the rudiments of these small ears, but is occasioned principally from bad culture, and want of nourishment ; because we see plants, raised from the same seed, will have large or small ears, according as they are cultivated."

" It is certain that the ears of wheat do not arrive at the size they are naturally capable of ; and if it was known at what period they were formed, the stinting of them might be prevented by a dressing, or culture, at that period.

" That there is some such period in nature, may appear from other circumstances in the growth of this plant. There is a particular season for its tillering, or spreading ; another for its upright growth ; and one for its blossoming and forming the seed ; and probably one also for the ear being formed : and the growth of it, in respect to each of these, may be promoted by culture, or retarded by a defect of nourishment, at these periods.

" When the season of tillering is past, no culture will make the plant throw out more branches ; and after the ear is shot out, it is then impracticable to make it larger, *viz.* to encrease the number of chests. Again, when it has blossomed, no art will cause the stem to rise higher. And, last of all, after the time of blossoming, there is no adding of one grain more than is already formed in the ear ; though, in all these cases, an addition, or improvement, may be made by culture, if applied at the proper time.

" It is therefore of importance to know the periods of growth of the different parts of the plant ; and that if we happen to miss assisting of it in one, we may improve it in another. If the season is lost to encrease the number of tillers, we may enlarge the ears ; or, if that is also omitted, we may encrease the number of grains in the ears, and make them larger, and fuller of flour.

“ It has been supposed, that the most important season for hoeing, for the purpose of filling the ears with grain, is, soon after blossoming; this I believe is a mistake, for before the blossoming is over, the grain is considerably advanced. I have found 77 grains in an ear of $4\frac{3}{4}$ inches long, and at the same time a considerable part of the blossoms still remaining. So that it seems very probable that the ears could produce a third part more than they usually do, were they assisted at that time with sufficient nourishment.”

By this experiment of this most intelligent writer, it appears a great deal of seed is lost, or does not produce; as if $2\frac{1}{2}$ bushels of seed were sown, and each grain produced 1 ear with 15 grains, the produce would be $37\frac{3}{4}$ bushels, or 15 after 1; whereas the produce is stated at only 20 bushels, nine-gallon measure, or nearly 22 bushels 2 pecks Winchester; by this the produce of $20\frac{1}{2}$ is only near 8 after 1, or nearly the one half of the seed does not produce.

In the drilled husbandry with 2 rows per ridge, 3 pecks are sown per acre for horse-hoeing.

A statute acre is 10 chains, or 220 yards long by 22 yards broad; as there are 28 rows of that length, which is 6160 yards, from which, allowing 6 yards from each, or 168 yards for head ridges, there remains to be drilled 5992 yards. By the table 3 pecks drilled, is 82 grains per yard of single rows.

In a yard of length (as the breadth of the ridges is 4 feet $8\frac{1}{2}$, or $56\frac{1}{2}$ inches, with the 2 rows) this is for each row 28 inches in breadth, which multiplied by the length, and divided by the grains, each grain has a space of 12 square inches, whereas in the broadcast, the grains have only a space of $3\frac{7}{10}$ inches.

In the broadcast husbandry there is nearly one-half of the seed lost: in the drilled, as the seed has 3 times the space, besides being free from weeds, and has the additional assistance of more nourishment
by

by the horse-hoeing, more of the seed may be expected to grow than in the broadcast.

In the horse-hoed land 3 pecks are drilled per acre; this is 164 grains per yard of double rows, allowing one-fourth of the seed not to grow, or to be destroyed, there remains 123. If each produce 1 ear at 40 grains is 123 ears per yard, or 25 bushels $1\frac{1}{2}$ gallon, which is more than the broadcast.

The above supposition, where one fourth is supposed not to produce, and the remainder to produce but one ear, shews what Mr. Tull says to be just: "That a good crop may be produced from 150 ears."

Of late, since the Rev. Mr. Cook's drill for equidistant rows was contrived, many comparisons have been made between that and the broadcast, by which it appears, this method produces much more.

Besides the instances mentioned in a former chapter, shall state an abstract of a few more.

	Equi-dist.			Broadcast.		Drilled superior.			Sup. value.		
	b.	g.	p.	b.	g.	b.	g.	p.	l.	s.	d.
Mr. Boot - -	23	0	0	19	0	4	0	0	0	0	0
Ditto. - -	29	6	0	23	4	6	1	6	2	3	3
Vol. of Annals	41	0	0								
	42	2	0								
Dr. Hinton -	44	0	2	38	1	5	4	0			
Mr. Dean -	30	4	0	28	1				0	13	0
17 Ditto	39	0	0	31	0	8	0	0			
Magenda - -	42	0	0	34	0	8	0	0	Includ. seed		
Mr. P. Smith	34	1	4	32	1	3	12	4	£.1	0	0

In the broadcast by Mr. Arthur Young's Tours to the South, through 600 miles, the average produce per acre of wheat was

wheat was	-	-	-	-	24
The highest	-	-	-	-	48
Average of barley	-	-	-	-	32

The tour through the East in 1790, forms the average,
Wheat - - - - - 24
The

The highest	-	-	-	-	30
file of Thanet	-	-	-	-	25
In the Northern tour, average					24
In a small tract where gentlemen have been at great expence	-	-	-	-	42

The method of cultivating the light land of Norfolk, is very different from the horse-hoeing, as mentioned by a Norfolk gentleman of great experience in agriculture, (whose name I am not at liberty to mention, not having his authority so to do) who tried an experiment for the purpose of ascertaining how long land might be kept in a state of profitable production of grain or pulse, merely by the drill husbandry of Mr. Cook, without fallow, turnips, or clover, from the year 1787 to 1794; it was drilled with wheat and peas alternately; in the unfavourable summer 1794, from a pea stubble. The produce was 14 quarters 2 bushels of wheat, from 4 statute acres 2 roods. Here is a practice almost the reverse of Mr. Tull's, and experience has convinced us of its utility. After clover lays once ploughed, then rolled down as close as possible, drilled or dibbled, after which we run our flocks over to compress the surface; the process of hoeing is used as much as possible to that surface in order to avoid loosening the soil.—This is a strong instance of the effect of hoeing upon such light land to produce 8 successive crops of grain, in place of 1 of grass and 1 of turnips in 4 years, and is certainly more beneficial to the public.

This judicious method of cultivation on such light land, experience has shewn by the above instance, that it is right; but this method is quite the reverse of the horse-hoeing; and although judicious and proper on such soil, would have a contrary effect upon strong soil, as the Tullian method would have on light land. Nevertheless many have adopted the Norfolk course in general upon all soils, particularly Mr. Arthur Young,

Young, to whose eminent talents, knowledge, and experience in agriculture, much deference is certainly due.

By the average of the comparisons which I have counted, stating the superiority of the equi-distant rows above the broadcast, it is nearly about 6 bushels per acre. The saving of seed in drilling is 1 bushel per acre.

This in a year of such scarcity as the present, becomes a considerable object to the country. In such a general view I shall state it as the President of the Board of Agriculture does in his Address, but confine it to wheat, and take Warwickshire, of which the acres of different grain is mentioned.

The acres in wheat are stated at 25,700. If drilled either in equi-distant, or horse hoed, allowing the saving to be 1 bushel per acre, would be $321\frac{1}{2}$ quarters.

As the superior produce of the equidistant by the experiments is supposed to be 6 bushels, but allowing it to be only 3, would be 9637 quarters. This is a difference of 12,850 quarters of wheat in one county only.—But as this is so much greater an object than most farmers take into their view, I shall state what many farmers have in wheat, 60 acres.

Saved in seed at 1 bushel 60, or $7\frac{1}{2}$ quarters	Quarters. $7\frac{1}{2}$
Superior increase at 3 bushels or quarters	$22\frac{1}{2}$

30

Or, at 2l. per quarter	- - -	l. s. 60 0
The difference of expence of broadcast, by statements of comparison of drilled with Norfolk course, where there is no expence for tillage at 10s. 6d. saving for one year	- - -	31 10
		91 10

COMPARISON OF HORSE-HOED WITH EQUI-
DISTANT ROWS.

THERE are no writers who mention comparisons between equi-distant rows, drilled at different distances, and horse-hoed with two rows upon a ridge, but Mr. Tull, till of late.

The first of these methods was Mr. Tull's first practise for many years, which he found inferior to the horse-hoeing husbandry.

Of late since new drills have been contrived; many have practised the first to great extent, but I do not find any that have practised his horse-hoeing, since Sir D. Legard; Mr. Wimpey, Rev. Mr. Dean, and Mr. Crack.

Mr. Tull mentions a comparison which he made between the equi-distant and horse-hoed; the first upon a fallow, and the horse-hoed was after a crop of wheat, which was preceded by three successive crops without manure, or fallow.

Many suppose that equi-distant rows at 9 inches, produce more than horse-hoed rows, with two rows per ridge of 4 feet 6 inches. Each drill occupying 2 feet 3 inches, leads them to suppose that most part of this space is lost.

To shew this is not the case; it is mentioned that Mr. Millar traced roots 3 feet long; and it is shewn, that single grains in rows at 3 feet, and 1 foot in the rows, produced double the number of ears.—Then 7 grains in a place, where planted in the same distance of drills, were at 3 inches distance in the rows.

In equi-distant rows at 9 inches, as directed to be drilled.

By the Rev. Mr. Cook's using his drills at 9 inches, there are 6 ridges in the breadth of an acre, with 12 drills is 72. This is 36 double rows, after deducting 6 yards from the length, supposed to be lost by turning
ing

ing on the head ridges, there remains 214 yards—This multiplied by the rows, make the whole length 7704 yards of double drills.

In 1 bushel of seed there is 976 ounces, and of common wheat 676 grains per oz. or 659,976 grains. This divided by the yard is $85\frac{6}{10}$ grains per yard of double rows.

The length of 1 yard of 2 single rows is 72 inches, this is $1\frac{3}{10}$ grains per inch of the drills—and each grain has a space of nearly $7\frac{1}{2}$ square inches.

In the horse hoed with 2 rows per ridge of 4 feet 6 inches, there is 14 double rows and two thirds, which is 3138 yards. The seed directed to be sown 3 pecks, which is 494,832 grains: this divided by the yards, is 157 per yard, which is nearly double the quantity of that of the equi-distant, and $2\frac{2}{10}$ grains per inch of the drills.

In the horse-hoed ridges of 4:6, there are 2 hollow furrows left open, one on each side; this leaves 3 feet for the 2 rows, which is 18 for each of space in place of 9—and multiplying 36 by 36, and dividing that by the grains, each has 8 square inches of space. By this the seed of the horse-hoed is double, and the space likewise double to the other per yard. It may be expected, it should produce double, which would be in proportion to the seed sown, or one fourth less.

If the equi-distant drills are supposed to produce 40 bushels per acre (and there are instances where 50 bushels are produced,) this would be 39,040 ounces, or 5 ounces per yard.—In the horse-hoed, if one fourth less, this would be 30 bushels, or 29,280 ounces, or $9\frac{3}{10}$ ounces per yard.

That the horse hoed should produce more than the equi-distant, in proportion to the seed, may be supposed from the superior culture it receives, which supplies it with fresh nourishment by the earth being laid to the roots that has been enriched by the at-

mosphere at the time it requires the most assistance, that is, when coming into ear, which increases the ears, as well as the size of the grain—And by pulverizing the soil, by which the roots have easy access to extend in quest of nourishment.

This benefit, neither the equi-distant, or broadcast have, for when these have extended their roots the short space, they have no more assistance, only a shallow hoeing, which only destroys a few surface weeds, but does not open the ground below.

Although the equi-distant should produce a greater crop, successive crops of wheat cannot be obtained in that method, although it must be much cleaner and freer from weeds than broadcast.

The difference of crops of wheat, and that of any other grain is considerable; but this is another consideration in favour of horse-hoeing.

The equi-distant rows must be ploughed several times to prepare it for another crop, and perhaps manured. This requires time, even was the wheat drilled upon one ploughing after clover or pease. But the horse-hoed ridges, whether for wheat or grain, requires at most 2 bouts, or 4 furrows to form a ridge, which in common ploughing, requires three bouts or 6 furrows to plough the same breadth. This is all that is necessary for land that is formed into ridges for horse hoeing.

Some suppose if more seed was sown in the equi-distant rows, the crop would be greater; but from Mr. Tull's long experience and practice, it is most advisable to follow his directions until experience shews us it is wrong, and giving allowance of more seed, where the farmer, from particular circumstances, finds it necessary.

Hand hoeing, no doubt, loosens the ground for an inch or two, and destroys weeds, but the ground below is stale and hard, by remaining so long unmoved.

Hoeing

Hoeing equi-distant rows is more expensive: hand-hoeing requires a great many labourers, and they cannot always be procured.

By the Tullian husbandry, both the intervals and partitions are hoed by horses. The partitions by two flims, and intervals deep hoed with a plough. This requires but a few labourers, even for an extensive farm, and therefore may be practised in many places where the other cannot, for want of labourers; but horses may be got where labourers cannot, and it is shewn fewer horses are necessary in this, than in the broadcast husbandry.

In the drilled land there is not above one third of the seed sown that there is in the broadcast, which is a saving of nearly two bushels per acre. This is not only an advantage to the farmer, but to the public: and as it requires a less number of horses, it is also a saving of a great deal of ground which is employed for grass and corn for horses, which would be much better employed for the maintenance for the inhabitants, or export.—This saving would amount to a very great quantity; allowing only 7 acres for hay and corn for a horse, 100 horses would require 700 acres.

That the horse-hoed produces successive crops of wheat, is shewn by many instances. The difference between 4 crops of wheat, and 4 crops in a course of any other grain, is considerable in value.—That horse-hoeing enriches and improves the ground, these instances shew; and this is not the case in any other culture, except in one instance, where drilled at 14 inches.

And that the land after horse-hoed wheat, is fit for a succeeding crop of wheat, is admitted by Mr. Young, who is no favourer of Mr. Tull's horse-hoeing husbandry.—He says: "after the equi-distant rows the land stands in need of a fallow. But the horse hoed is prepared for a fresh produce, and

is vastly superior to the state of a fallow, in the fields of a common farmer."

Some suppose this method is the same with a fallow and crop of wheat alternately, (which is found to decline without manure)—As the difference only is, that the fallow in the horse-hoed is upon the same ridge with the crop, and the other is upon a different field from the crop.

But the horse hoed is quite different; for in the broadcast while the crop is upon the ground, the land receives no manner of culture, neither does the crop, and is liable to all the inconveniences the broadcast is mentioned to be, and it is generally left to struggle with the weeds, and three times the quantity of seed is used, more than is sown in the drilled: this and the weeds greatly impoverish the land.

And as the broadcast lies so long uncultivated and turns hard, it cannot receive that benefit from the influence of the atmosphere, which the drilled does by being cultivated and open to receive it, and horse-hoed when the crops are on the ground, as well as the hoeings to prepare for the crop, which makes 4 hoeings to prepare the land for the crop, and 4 hoeings when the crop is upon the ground. By these means the *horse-hoed* is much more enriched by the cultivation, and less exhausted by weeds and seed; by this the drilled crop appears no more exhausted, than what is fully replaced by the horse-hoeing; and which the fallowing of the broadcast appears not sufficiently to do.

And in good ground, where 30 bushels are produced per acre, the broadcast to equal this, must produce double.

From the instances stated, it is shewn, that the horse-hoed improves the soil, so as to produce successive crops of wheat without manure, which is not yet experienced in any other case.

And

And that barley or other grain is encreased by being sown broadcast, after a horse-hoed crop of wheat.

Every farmer finds by experience, that wheat requires the land to be richer than for barley or other grain, and therefore gives it more tillage, or fallow and manure.—And that wheat after barley or oats is never a good crop, which shews the land is more exhausted than after a horse-hoed crop of wheat; and I believe no farmer would expect a crop of broadcast wheat, after a preceding crop of wheat: but in the horse-hoed, repeated successive crops are obtained after wheat for years, which shews the land is not impoverished by the crop.

Every farmer knows that land prepared for wheat produces great crops of barley, and other grain; therefore may expect good crops of drilled barley after drilled wheat.

But as the principle and practice of gardeners and farmers prejudice them so much against successive crops of wheat, they have, therefore, on that account so long rejected Mr. Tull's method altogether. But although Mr. Tull's practice, was the most profitable, yet the success of this husbandry does not depend upon successive crops of wheat, but on improving the ground: therefore farmers may so far follow that part of Mr. Tull's plan as to horse-hoeing, it being shewn that his method produces successive crops of wheat; they may follow their accustomed method of change of crops, which although it may not be altogether so profitable as the other, yet it may be expected to be more profitable than the broadcast or equi-distant, by increasing their crops. By this method more grain may be produced with less manure or fallows, or being under the necessity of laying down so much land to grass, because it is so much impoverished by broadcast crops, that it will not produce corn without manure, which cannot be procured.

This

This was Mr. Tull's last method, which he recommends as the best, which is, bringing the garden culture into the fields, by giving nourishment to the grain, while growing, in the manner gardeners do to their plants.

This we see has so far extended to the field with great success; by drilling or sowing in rows, and hoeing potatoes, cabbage, beans, peas, turnips and carrots, for the London market: and beans drilled is now the common practice, and also turnips, from which they find very great increase. Drilling or furrowing has long been the practice in Kent, and there is no reason why it may not answer equally well with wheat as beans, &c. But prejudice being now got the better of by Mr. Tull's first method, it would be surprizingly obstinate in them not to make trial of his last method, who were convinced of the advantages of his first method, though much prejudiced against it. To Mr. Tull this country is much indebted. From his system the intelligent farmers have learned to give more culture to their land, from which they have found great advantage, but they have not followed his last method; which it is hoped will be found equally successful as the other, which has increased more rapidly than any other new improvement for a century past.

Mr. Adams, a most intelligent and judicious author, in his *Practical Essays on Agriculture*, in vol. 2, which treats fully of the common husbandry, and *quoting* the authorities of the best farmers and authors says, "Having given an account of every useful circumstance I collected from my own experience, or that of others, relative to the culture and management of wheat, not only of those articles which must be attended to in the old husbandry, but of many which are also necessary in the new, or what is commonly called the Horse-hoeing Husbandry, a species of cultivation superior to the former in every point of view,

view,—It now becomes highly necessary that we describe its advantages.”

In treating of the drill husbandry and horse-hoeing, he mentions all the different methods of drilling and dibbling, and quotes many things from the authority and opinions of Mr. Anderdon, (formerly mentioned) he says, “Mr. Anderdon thinks the drill plough, judiciously used, a very great acquisition to agriculture, and is of opinion, from experience, that the use of it is not only the best method for putting in wheat, in the horse-hoeing or Tullian method, but also when the whole field is seeded with that grain, sowing it in equi-distant rows, and in that way too, with barley, oats, and vetches.—That successive crops of wheat are profitable, but is rather inclined to think the horse-hoeing husbandry would be most profitably carried on by a change of crops: but a great respect and consideration ought always to be had in favour of the Tullian mode, from the vast advantage arising by the ground being clear of weeds, which advances in proportion to the length of time that the ground has been well managed under that mode, and not made foul, by carrying into it the seed of weeds with dung; therefore Mr. Anderdon strongly recommends to the farmer whose ground is adapted to wheat, to introduce them in the course in the Tullian mode, and to take two, three, or four successive crops of them, which may as well be taken as *one*.”

Mr. Adam says, “Whatever objections may be raised to this mode of cultivation, I will venture to pronounce in its favour—That I know of none by which land will be kept so clean, or in such perfect tilth and good heart, for producing uninterruptedly excellent crops of wheat. I have given in the article of sowing, so full an account of drilling with Mr. Cook’s drill, it would be perfectly superfluous to add any thing more, except to say, that upon clean land this is the mode of culture, I would prefer to others, as
being

being productive of the largest crops at the least expence.

This manner of drilling at nine inches produces very great crops, as is shewn by Mr. Boot and others, and considerable profit as mentioned by him, but cannot clean the land so well as the horse-hoeing, or leave it in such order for a succeeding crop. Mr. Adams, in treating of the horse-hoeing husbandry says, "The pulverization of the soil is of the greatest consequence. It opens the earth, and makes every particle of it useful to vegetation. It allows the fibrous roots of plants to shoot and collect their food, it conveys that food with facility, imbibing and imparting moisture without being endangered by receiving too much, or by retaining it too long. Stirring the ground also destroys weeds, and exposes fresh mould to the benign influence of the air.

Mr. Adam says, "All this may with great truth be said of Mr. Tull's system, but it does not follow from hence that manures are of no other use than to divide the soil. He shews instances, as the most convincing proof to the contrary. Manures laid upon meadow lands do not divide the soil, yet improve the crop by imparting new pabulum to the plants.—Plants in ploughed land must derive the same or greater benefits from an increase of pabulum.

It is shewn, that the equi-distant drilled wheat and barley produces larger crops than the broadcast; and also one instance is shewn that in light land as Norfolk, 8 successive crops of wheat and peas were produced. In the horse-hoed is shewn many successive crops of wheat have been produced without manure; and that Mr. Tull, on good land, had above 4 quarters per acre; the Rev. Mr. Dean above 20 years successive crops, from 2 to 4 quarters and upwards; Mr. Crack, on an average of 7 years, on bad ground, 25 bushels; all without manure. There is every reason to believe that land that is in order to produce wheat, as in the horse-hoed, will produce great crops of

of other grain, that will be superior in profit to the 20 bushels stated in the comparisons with the Norfolk course, and by producing more crops of grain, will be much for the benefit of the public; as well as equally great benefit that is shewn may be produced by drilling equidistant rows, by the increase and saving of seed.

COMPARISONS OF HORSE-HOED WITH NORFOLK
COURSE.

A FARMER sows an acre with $2\frac{1}{2}$ or 3 bushels of wheat, after the land has been properly prepared by fallow, or manure, and is accustomed to reap, or expect from 20 to 24 in return, or 8 after one: and if the farmer counts the grains per ear, of his wheat, he will find them of various sizes, as Mr. S. states. But if he will try the experiment of the same wheat upon the same land, by planting a few yards in rows, at 2 or 3 feet distance, he will be surprized to see the difference not only in the size of the ears, but in the circumstance that several ears are produced from one grain: and if he will take the trouble to number the grains sown, he will find them all grow, if good, and not destroyed by accidents; but he is not surprized at receiving, by the common mode of cultivation, only 8 in return. If an intelligent farmer inquires into the cause of so small an increase, the general answer is *the land is not rich enough to produce more*: but if the experiment is tried of planting a few yards in rows, that will shew it not to be the case: and it is sufficient to shew the farmer the fact by such an experiment, that more space, and destroying the weeds, and more cultivation, produce a greater crop, to which deeper hoeing, or horse-hoeing will greatly contribute.

The instances formerly stated in the chapter on Produce, shews that horse-hoed grain, particularly wheat (which has been most sown in this method) produces crops equal to broadcast even for *one* year.

T

And

And by the ascertainments formerly stated of the produce and comparisons between wheat drilled in equal distant rows and broadcast, together with Mr. Boot's comparisons, shew the superiority of the produce of that method, as well as the superiority of the profit for one crop.

But it is not asserted that horse-hoeing culture is always superior to broadcast for one crop; as a great deal of the sown wheat is upon fallow or manured land, and often both; but that the horse-hoed is more profitable for a course is shewn by the following instances.

Sir

Sir Digby Legard made the following comparisons.

TURNIPS.

		EXPENCE.		PRODUCE.	
		l. s. d.	l. s. d.	l. s. d.	
4 Ploughings at 4s.	. . .	0 16 0			
Harrowing and feed	: . .	0 2 0			
Hoeing	. . .	0 6 0			
15 Loads of dung, at 2s. 6d.	. . .	1 17 6			
Rent	. . .	0 15 0			
			3 16 6	2 0 0	

B A A L E Y.

2 Ploughings & harrowings	0 10 0				
3 Bushels of feed, & weeding	0 8 0				
Hoeing, reaping & harvesting	0 4 0				
Threshing 4 quarters at 1s.	0 4 0				
Rent	0 15 0				
			2 1 0	4 qrs. at } 18s. }	3 12 0

C L O V E R.

14lb. Clover	0 4 0				
Rent	0 15 0				
			0 19 0	2 crops	1 10 0

W H E A T.

1 Ploughing and harrowing	0 7 0				
3 Bushels of feed, & weeding	0 16 0				
Reaping and Harvesting	0 7 0				
Threshing 3 quarters at 2s.	0 6 0				
Rent	0 15 0				
			2 11 0	3 qrs. at } 11. 16s. }	5 8 0
				Produce	12 10 0
			Total expence	9 7 6	Expence 9 7 6
				Profit	3 2 6

T 2

From

From Dr. Hunter's Georgical Essays.

T U R N I P S.

	EXPENCE.			PRODUCE.		
	l.	s.	d.	l.	s.	d.
4 Ploughings and harrowings, at 3s. 6d.	0	14	0			
12 Loads of manure and carriage	3	0	0			
Seed and hoeing . . .	0	8	0			
Rent	1	0	0			
				5	2	0
					3	0

B A R L E Y.

3 Ploughings, at 3s. 6d.	0	10	6			
Seed 2 bushels, at 2s. 6d.	0	5	0			
Reaping, beer, & getting in	0	8	0			
Threshing 4 q. 4 b. at 1s.	0	4	6			
Rent and tythe	1	0	0			
				2	8	0
				4 q. 4 b. }	4	10
				at 20s. }	0	

C L O V E R.

Cutting and making . . .	0	3	0				
Carrying 5s. . . . }	0	12	6				
Second ditto 7s. 6d. }				3 load at }	3	0	0
Seed	0	10	0	20s. }			
Rent	1	0	0	2 ditto }	2	0	0
				2	5	6	

W H E A T.

1 Ploughing and harrowing	0	4	0				
2 Chaldrons lime & carriage	1	10	0				
2 Bushels seed	0	10	0				
Reaping and beer	0	7	6				
Carrying	0	5	0				
Threshing 3 q. 4 b. at 2s.	0	7	0				
Rent	1	0	0				
				4	3	6	
Total Expences	13	19	0	3 q. 4 b. }	7	0	0
				at 20l. }			
				Produce	19	10	0
				Expence	13	19	0
				Profit	5	11	0

From

From Mr. Young.

TURNIPS.

	EXPENCE.			PRODUCE.	
	l.	s. d.	l.	s. d.	l.
4 Ploughings, at 5s	1	0 0			
Harrowing	0	2 6			
Seed and sowing	0	1 3			
Manuring	1	10 0			
Rent	0	15 0			
		<u>3 8 9</u>			2 0 0

BARLEY.

3 Ploughings	0	15 0			
Harrowing	0	2 0			
Seed and sowing	0	12 3			
Mowing and harvesting	0	4 6			
Threshing and carrying out . .	0	6 8			
Rent	0	15 0	2 15 5	4 quart. } at 24s }	4 16 0

CLOVER.

Seed and sowing	0	5 3			
Mowing and making	0	15 0			
Rent	0	15 0	1 15 3	3 Loads of } hay at 30s }	4 10 0

WHEAT.

1 Ploughing	0	5 0			
Harrowing	0	1 0			
Seed and sowing	0	12 6			
Reaping	0	5 0			
Harvesting	0	2 0			
Threshing 3 quarters at 2s . .	0	6 0			
Rent	0	15 0	2 6 6	3 quart. } at 48s }	7 4 0
Total Expence	10	5 11		Produce	18 10 0
				Expence	10 5 11
				Profit	8 4 1

DRILLING

DRILLING EXPENCES.

EXPENCE.				PRODUCE.			
	l.	s.	d.	l.	s.	d.	
2 Bouts to form the ridge . . . }	0	2	8				
3 Pecks of wheat	0	3	9				
Drilling at 6 per day . . . }	0	0	8	2 quarters of wheat at the average of the other . . . }	4	2	8
4 Horse-hoeings	0	5	0	Straw	0	14	0
Hand-hoeing rows . . . }	0	4	0				
				0	16	1	
Reaping & har- vesting . . . }	0	7	0				
Threshing 2 qrs.	0	4	0	Produce	4	16	8
Average rent of the other }	0	16	8	Expences	2	3	9
				1	7	8	
Per year	2	3	9	Yearly profit	2	12	11
4 Years 8 15 0				Produce of 4 years	19	6	8

SECOND.

Expences as above	2	3	9	2 Quart. 4 bufh. }	5	3	6
Extra reaping }				at average }			
& harvetting }	0	1	6	Straw	0	14	0
Per year	2	5	3	4 Years 5 17 6			
				4			
4 Years 9 1 0					5	17	6
				23 10 0			
				Expences . . .	2	5	3
Expences as above	2	5	3	3 Qrs. wheat . . .	6	4	0
Extra	0	1	6	Straw	0	14	0
Per year	2	6	9	Produce	6	18	0
Per year 2 6 9				Expences	2	6	9
4							
9 7 0				Profit	4	11	3
				6 18 0			
				4			
				27 12 0			

ABSTRACT

ABSTRACT OF BROADCAST.

	EXPENCE.	PRODUCE.	PROFIT.
	l. s. d.	l. s. d.	l. s. d.
1 . . .	9 7 6	12 10 0	3 2 6
2 . . .	33 19 0	19 10 0	5 11 0
3 . . .	10 5 11	18 10 0	8 4 1
Total . .	33 12 5	50 10 0	16 17 7
Per year .	2 16 1	4 4 2	1 8 1 $\frac{7}{12}$

ABSTRACT OF THE DRILLED.

	EXPENCE.	PRODUCE.	PROFIT.
	l. s. d.	l. s. d.	l. s. d.
1 . . .	8 15 0	19 6 8	10 11 8
2 . . .	9 1 0	23 10 0	14 9 0
3 . . .	9 7 0	27 12 0	18 0 5
Total . .	27 3 0	70 8 8	43 5 8
Per year .	2 5 3	5 17 4 $\frac{8}{12}$	3 12 1 $\frac{8}{12}$

The following Abstract shews the Expence of the Tillage of each, the Rent, and Harvesting Expences for four Years.

BROADCAST.

DRILLED.

	Til.&feed.	Rent&har.	Til.&feed.	Rent.&har.
	l. s. d.	l. s. d.	l. d. s.	l. s. d.
Total .	19 0 3	14 12 3	9 13 0	17 10 0
Per year .	1 11 8	1 4 4	0 16 1	1 9 0

These

These comparative statements of the Norfolk husbandry and the horse-hoed are made to shew the difference of the expences and produce of the two methods upon such land that is stated at 15s. per acre. But it is by no means supposed, that the horse-hoeing method will have the same effect upon very sandy soil, as upon such land as Sir Digby Legard, Mr. Young, and Dr. Hunter made their experiments upon.

Such soil the frequent hoeings keep open to receive the vegetable food from the atmosphere, which it imbibes and communicates to the roots of the plants. But where there is much sand, that part of the soil cannot imbibe or retain that food; or communicate it to the plants. Therefore the management in the two should be very different.

Sir Digby Legard also made a comparison between broadcast and drill husbandry, as mentioned in his letter to the Society of Arts, upon a field of 7 acres. The actual produce of the field of 7 acres, horse hoed, without dung, during 8 successive years was,

Acres.	Years.	ACRES.		l.	s.	d.
7	1	{ 2 oats	Total produce	161	11	0 $\frac{1}{2}$
		{ 5 barley	Deduct value of			
7	2	{ 4 wheat	feed	7	14	4
		{ 3 barley				
7	3	{ 4 wheat				
		{ 3 barley				
7	4	{ 4 turnips	1 15 0 per acre			
		{ 3 barley				
7	5	7 barley				
7	6	7 wheat				
7	7	7 wheat	Neat produce in			
7	8	7 wheat	8 years - - -	153	16	9 $\frac{1}{2}$
			Is per acre per			
56 acres			year - - -	2	14	11

COMMON

COMMON HUSBANDRY.

Acres.	Years.		l.	s.	d.
7	1	turnips			
7	2	barley	Total value . .	147	11 8
7	3	clover	Deduct		
7	4	oats	feed 9 10 7		
7	5	turnips	210 load		
7	6	barley	dung 21 0 0		
7	7	clover		30	10 7
7	8	oats			
56 acres			Is per acre . .	117	1 1
				2	1 9 ⁸ / ₁₂
Total neat Produce.			Produce of drilled per acre.		
Drilled	153	16 9	Drilled per acre	2	14 11
Broadcast	117	1 1	Broadcast . .	2	1 9 ⁸ / ₁₂
36 15 8 drilled superior				0	13 1 ⁴ / ₁₂

“ It is presumed that the ploughing expences are nearly equal in each method : the expences of ploughing are generally more in the common husbandry, than in the new. The land is once ploughed to form the ridges for wheat or other grain, and four times horse-hoed afterwards, not exceeding two ploughings in all. But in the old husbandry, all the land is usually ploughed three times, and often with four horses; whereas two horses are sufficient for hoeing the fore-mentioned, which is valued at 15s. per acre.

	l.	s.	d.
Consequently the rent of 7 acres in 8 years is	42	0	0
Ploughing expences, and fallow	42	0	0
For rent and tillage of 7 acres in 8 years .	84	0	0
Total produce of 7 acres in 8 years is . . .	153	16	9
Deduct rent and tillage	84	0	0
	69	16	9
U	Which		

Which is 11. 5s. clear annual profit from an acre. And though this profit be not near so considerable, as I before computed from an actual crop of barley, where the land was in fine order, yet I judge it sufficient to demonstrate the advantage of pulverization.

THE OLD METHOD.

	l.	s.	d.
Acres in 8 years the same as above . . .	84	0	0
Total produce of 7 acres in 8 years in the Old Method	117	1	1
Deduct rent and expences as above . . .	84	0	0
	33	1	1

which is not quite 12s. clear annual profit from one acre. Though this clear profit be much less than I calculate, yet I apprehend there are many farmers hereabouts who do not clear more."

In Vol. IX. of the ANNALS of AGRICULTURE, is stated the expence and profit of a farm of rich land. The farm consisted of 146 acres. As the produce as well as the profit is high, I shall state the comparison with the drilled.

Produce.

	l.	s.	d.
Rent, tythe, and rates	168	0	0
Labour	140	0	0
Wear and tear	30	0	0
Team	60	0	0
Seed	45	10	0
Interest of the capital 646l. 18s. 7d. at 5 per cent.	32	6	0
Expences	475	16	0
Expence per acre 3l. 5s. 2d.			
146 Acres			

	Acres.	Quarters	Shilts.
Beans	20	4	at 28
Wheat	20	4	at 40
Barley	40	5	at 20
Oats	15	5	at 20
Turnips	10	0	at 40
Fallow	15	0	
Grass	20	0	at 40
Hogs			
Straw-yard by cattle			
Acres	140		
Produce per acre } 4 9 3½			
Expence 3 5 2			
Profit 1 4 1½			

	l.	s.	d.
112	0	0	
160	0	0	
200	0	0	
75	0	0	
20	0	0	
40	0	0	
20	0	0	
25	0	0	
652	0	0	produce
475	16	0	expence
176	4	0	profit

The Publisher of the Annals makes the following Remarks: "The soil of this farm is capital; in general a deep rich soil. The leading features is the absence of cattle and sheep. There is no clover; little grass, and no live stock, but the team and the hogs. The turnips always sold to be fed off the ground by the stock of other people: this is a remarkable circumstance; and it is that upon which the great profit depends."

There is no article upon a farm, which it is so difficult speedily to convert to profit as cattle and sheep. Hazard, accident, and losses, come largely into that part of the farmer's business, and if there is not a considerable degree of skill, loss, instead of profit, is too often the result upon farms, even where every other article is decisively profitable.

A Comparison with Drilled Wheat, 146 Acres.

	l.	s.	d.		l.	s.	d.
Rent, tythe, and rates	168	0	0	120 Acres wheat			
Drilling, ploughing, and all drilling expences	105	0	0	at 20 bush. per acre, = 300 quarters at 2l.	600	0	0
Harvesting 120 acres, at 6s. per acre	36	0	0	Straw at 14s.	84	0	0
Threshing do. 300 quar- ters	30	0	0	Grass, 20 acres	40	0	0
Interest 400l.	20	0	0	Produce	724	0	0
	359	0	0	Expence	359	0	0
				Profit	365	0	0

BROADCAST ABSTRACT.

	l.	s.	d.	146 Acres.	l.	s.	d.
Produce per acre -	4	9	3	Total produce - -	652	0	0
Expences - - -	3	5	2	Expences - - -	475	16	0
Per acre - - -	1	4	1		176	4	0

ABSTRACT DRILLED.

	l.	s.	d.		l.	s.	d.
Produce per acre -	4	19	0	Produce - - - -	724	0	0
Expence - - - -	2	9	2	Expence - - - -	359	0	0
Profit - - - -	2	9	10	Profit - - - -	365	0	0

If from winter setting in early, or from any other cause, the farmer is prevented from drilling all his wheat, we see, from many instances, that by the Tullian husbandry he may produce great crops of barley, oats, and beans. I do not find the produce of these last mentioned by any author, when horse-hoed with wide intervals. But of drilling them at 18 inches, there are many instances. I have had the experience of barley and beans producing great crops, when horse-hoed in these narrow spaces. To drill beans, is, in many places, the common practice; and I have known a produce of 48 and 50 bushels per acre, when drilled at 18 inches. No doubt this would put the land more out of tilth, and it would be neither so clean or pulverized, as after deep horse-hoeing. But this may to a certain degree be remedied, by manuring for those crops with such manure as brings the fewest weeds, and by a little more hoeing.

Here there is no produce stated for the 6 acres: neither is there any thing stated for hogs or straw yard, as the straw is stated. This superiority of the Tullian mode of cultivation is very great, if we consider

sider that it is stated as the produce of such bad land as Mr. Tull's and Mr. Crack's. And the broadcast with which they are compared, is upon ground much superior by the publisher's account of it.

From the experiments and practice I have had, I should suppose near four quarters should be the produce of such land properly cultivated and pulverized.

I have stated these expences of the drilled at the highest rate, although some of them are done at much less. Reaping is done at little more than half the expence, where it has been tried, and threshing at the same. But I have stated them, where high, much above the average.

The following scheme of the Drill Husbandry, probably by one experienced in the New Husbandry, shews the quantity of ground that may be managed by a pair of horses, in the drill husbandry, and a state of the expences, produce, and profit, in a different view.

As it is accurate in describing the manner of the different operations, which may be of use to those who are inclined to practice this husbandry, I shall transcribe it, with some remarks, from Select Essays, printed at Edinburgh, 1774.

SCHEME OF HORSE-HOEING HUSBANDRY.

" Farm 240 drilled wheat, 50 corn and pease, 50 to lie in grass, 340 acres in all. The manure collected to be laid on the grass, in order to enrich it, for being broke up in its turn. Six men and six horses through the year.

" And two men and four horses from the beginning of September to Martinmas. But for ease of calculation, sets the whole at 8 horses, 7 servants, for the year.

" To avoid calculation of the price of labour of different parts of the country, we shall allot the 100 acres of corn and grass to maintain the horses and servants, and pay wages, and pay rent, and furnish feed for the 100 acres.

	l.	s.	d.
1. The rent 10s. per acre. 240 Acres	120	0	0
2 Stock for this undertaking 500l. at 10 per cent. - - - - -	50	0	0
3 Eight horses, value 90l. on which 15 per cent. - - - - -	13	10	0
4 Carts, ploughs, drills, &c. called 80l. at 15 per cent. - - - - -	12	0	0
5 Seed wheat, at 3 pecks per acre, 45 bolls at 15 per boll - - - - -	33	15	0
6 The hand-hoeing and weeding rows, at 2s. 6d. - - - - -	30	0	0
7 Cutting down corn, at 2s. 6d. - -	30	0	0
Threshing out 1200 bolls at 5 * bolls per acre - - - - -	36	0	0
	325	5	0
1200 Bolls, at 5 bolls per acre, and selling the grain and fother at 15s. per boll, or 3s. 9d. per bushel, is 3l. 15s.	900	0	0
Expences - - - - - 1l. 7s. 1d. -	325	5	0
Per acre 2l. 7s. 10½d. - - - - -	574	15	0

* A boll of wheat and beans is 4 bushels Winchester, and of barley and oats, it is 6 bushels.

This

This makes 60 acres of drilled wheat, and 25 of the 100 for each pair of horses of 4 ploughs, or $12\frac{1}{2}$ of the 50 broadcast that is laboured.

This calculation comes out so large on the profit side, that a deduction may be made from the crop, as an addition to the expence of management.

The proportion of ground to the strength of the men and horses above, so much exceeds the allowance in the common method of labouring, that it seems to need explanation.

EXPLANATION.

The foregoing supposition depends upon the most favourable supposition both of the soil and climate.

That from the 1st of March to the middle of July, the ground may be dry enough to allow 5 days ploughing each week. The best soil for this husbandry is a loam or black earth upon a sandy bottom, and in such a soil upon the East coast, the allowance of 5 days in the week may be given.

In more rainy climates, or wetter soils, a deduction may be made.

But be the soil and climate what it will, each of the 6 horses employed in summer ploughing, takes on eight acres of wheat for every ploughing day allowed in the week, over and above the quantity of ground allowed for labouring in the common way as above, that is to say;

Allowing 5 ploughing days per week. Each horse takes on 40 * acres of wheat, and allowing 4 days, only 32, and so on to one day.

Suppose 240 acres dressed in 5 feet ridges, and the crop drilled in two lines upon the top of each ridge, the partition between these two being 6 or 8 inches, &c.

* This is 80 acres for each plough in the summer, for three ploughs.

The

The strength supposed for spring and summer ploughing being 6 horses, is 3 two-horse ploughs.

Each plough, in 8 hours, by turning the furrow from the wheat, to make a veering or ridge in the interval where the trench was before, ploughs 3 acres.

This every ploughing day clears 9 acres; and consequently the given acres are done over for the first time in something less than 27 days.

The second turning this veering or ridge to the wheat rows on each side, and as performed by a plough having a double mould board: this plough requires three horses; and it throws out in this manner, 6 acres per day; consequently two of these ploughs turning 12 acres per day, go over the whole in 20 days.

The third ploughing is performed as the first.

And the fourth as the second—94 days being the time it takes to finish the operation.

But the ploughing days between the first of March, and the middle of July, computing at 5 days per week, is 98.

The ploughing necessary to form the ridges for the seed cannot so easily be computed; I mean, proportioned to the strength. As the “labour of four additional horses between the months of September and November must be applied here at such times as they are not employed in carrying in the crop, which is uncertain.”

When the veerings are formed whereon the next crop is to stand, we throw them in with a strong plough, (to which we put three horses) at two furrows, and the hintings, on which the last crop stood are thrown out by the double mould board plough.

The hintings can be thrown out in the wettest weather, so that we reckon we can plough all the 6 days of the week in the go-harvest.

The reason we take 3 horses to form the veerings for the next crop, is to give a greater depth;

Because upon the height and fineness by pulverization of the veering, depends the goodness of the crop.

In general 60 days ploughing of the ploughs forms the ridges. *

Twenty days harrowing with two horses—and 20 days drilling with a single horse, finishes the whole.

As to the 100 acres proposed for the common method of labouring, these are to be one half in grass, and the other in spring crops alternately; so that these crops must have but one ploughing between Martinmas and the beginning of March.

All the dung and manure that can be got ought to be laid on the grass.

And as the 240 acres in wheat requires no dung, but on the contrary adds greatly to it—It is supposed that the corn crops on breaking up the grass will not be inconsiderable.

Schemes may be formed for improving this part of the Plan. But as these require a great many horses, they do not fall within this Design—which is to show how much more ground may be cultivated in this way, than can be by the common methods with the same strength, and how much better crops may be obtained.

As I have stated the expence high, so I have brought the crops low, both as to value and quantity.

As to the value, it is to be noticed, that the horse-hoed wheat is always 1s. 6d. or 2s. better than the common wheat: and as to the quantity to be got from an acre, I shall relate my own experience—which is from a field of 11 acres; one-third thereof is good ground;—about half middling ground; and a sixth very bad thin soil, and on a bottom of pure sand.—

The

The whole may be called a fertile dry soil. When it came out of the tenant's hands,

The first crop was	—	Broadcast oats;
The second	— —	Beans and peas;
The third	— —	Drilled barley for hand-hoeing;
The fourth	— —	Barley, horse, &c.

And till now the eighth crop is standing on it.—It has been in wheat, horse-hoed, the four last years.

About 2 acres of the lower part of it was trenched the first year, but none of it has got any dung, or manure, since the tenants left it.

The horse-hoed barley had	4	bolts, or 24 bushels.
The 5 of wheat - - -	6	bolts, or 24 bushels.
6 Ditto, wheat - -	5	bolts, or 20 bushels, being damaged by the over-flowing of the ri- ver.
7 Crop had of wheat	7	bolts, or 28 bushels.
8 And present crop, 1759, ditto - - -	7 $\frac{1}{4}$	bolts, or 29 bushels.

The philosophical tenets necessary for a farmer may be reduced to four heads:

1st. That spreading, or increasing the roots of his plants augments his crop.

2d. That deep and frequent ploughings facilitate the spreading and increasing of the roots.

3d. That exposing the surface frequently up to the sun and air, especially in summer, adds to the fertility of his soil.

4th. That there is a certain proportion of seed and numbers of plants, which will give the greatest crop on a given quantity of ground.

“ He ought to find out this, and apply the whole strength of his ground to his crop, only taking care

to destroy all intruders that endeavour to come in for a share of it."

By the above statements, three pair of horses each in summer, hoes 80 acres, and the four pair manage in the year, at an average, 60 acres drilled, and $12\frac{1}{2}$ of spring crop; and one pair of horses is supposed to be employed about other work in the summer.

In the common husbandry, there are seldom fewer than 6 horses to labour 100 acres.

In place of 7 men to 4 ploughs, or 8 horses, one man is only necessary to a plough with 2 horses, as is the practice in many places.

And it is surprising this practice is not more followed in loam and light lands.

When one sees more than 2 horses to a plough in such grounds (perhaps in the next county, and sometimes in the next farm to one, they plough with only two) he is irresistibly led to entertain an opinion, that the farmers must be very tenacious of old customs, or very ignorant of the practice of his neighbours, to throw away so much money, notwithstanding the conviction of the practice of his neighbours.

By the above scheme, many of the articles may be thought too low, and the profit small. But 574l. 15s. $0\frac{1}{2}$ profit is gained by 8 horses and 7 servants, which I believe is much more than can be got in the broadcast by the like number.

The instances above stated of the Norfolk course of farming shows turnips to be a losing crop to the farmer. And Mr. Young, in his Tours through the East of England, shows the average price of an acre of turnips is 2l. 16s. even where the rent is high, and where they are hand-hoed; and where they are not hand-hoed they are only 1l. 16s. 9d.

In the XVth Vol. of the Annals of Agriculture, Mr. Dunn states the expence of turnips at 6l. 17s.; others state them at 3l. 7s. per acre. But all of them show they are a losing crop. This loss the farmer

mer is at to procure manure and destroy weeds by the summer fallow and hand-hoeing.

Manure is so necessary to broadcast crops where land is much exhausted, that they find it necessary to be at great expence rather than not procure it.

The Norfolk Course with turnips and clover, has been a great improvement in such light lands as are adapted only to turnips, and not so proper for producing wheat or other grain. On these this course has been successful, where farmers have great stock, to purchase large flocks of sheep; and is much recommended by writers on husbandry, therefore many follow it on all soils.

But on other soils, other crops may be raised, in drill husbandry, which would produce more profit, and at the same time clean the land as effectually as turnips: and also afford as much manure; as beans, potatoes, cabbage, when in the hoeing husbandry.— It is a poor crop of beans, potatoes, or wheat, horse-hoed, that is not above double the value of turnips. And, as formerly shewn, it is a poor crop of drilled wheat that does not produce above two quarters per acre; and this we see is a profitable crop, as shewn by Sir Digby Legard, and is less expensive than turnips.

It is needless to tell a farmer, (now that feeding on potatoes is more generally known) that cattle and all animals may be fed on them with more profit than on turnips.

And these, as well as wheat, horse-hoed, upon ground poor and foul, I have found from experience, clean the ground better than hand-hoed turnips, at less expence without manure, and with considerable profit in place of loss.

In some parts of Vol. I. of the Annals of Agriculture, Mr. Young condemns the Tullian, or hoeing husbandry; but from the instances above stated,
it

it appears to be far from meriting so general a condemnation as he bestows.

Experience is certainly the best standard to judge by; and Mr. Young's numerous experiments seem to prove that he had its authority for forming his opinion. His bad success is certainly an unlucky event for the drill husbandry, at the same time it seems probable it arose, in a great degree, from his ground being remarkably bad, from his want of drills, or from his using improper ones—we are warranted in saying his ground was remarkably bad from the poverty of his broadcast crops. It should be added, that his experiments were small, made with the spade, from these his calculations are formed, and from these arose probably his prejudices against the new husbandry. From the same causes arose also his high statement of the expence of this mode, in which he very materially differs from many extensive practisers, and from my own experience.

A great saving may be made by employing oxen, as they answer in every respect for all work of a farm equally well with horses, for ploughing, harrowing and carting. And I have used a plough with two oxen, without a driver, in the same field with horse ploughs; and two oxen for driving stone for several summers along with horse carts. They wrought for an equal space of time with the horses twice a day. The oxen went to the quarry six times, and the horses seven; but the oxen carried above one fourth more each time than the horses. The oxen were fed in winter with turnips and hay and straw; and in summer upon cut grass.—The horses were fed with hay and corn in the winter. The oxen are as manageable as horses, if not more so. A well-made ox, when walking at liberty, walks as fast as a horse.

A learned Author, in the Gentleman Farmer, has a chapter on the subject of cattle and carriages. He states

states the comparison of the expences between horses and oxen.

He states the maintenance of a horse for one year only 6l. 13s. 4d. and that of an ox at 2l. 3s.; and by a calculation of how much a farmer saves by employing oxen for twelve years instead of horses; he states the saving to be 6l. 3s. 8d. per year: calculating the sale of the cattle on the one hand, and the decline of the horses on the other.

He states the number of horses in one county at four horses to a plough, and the corn consumed by them at the lowest prices and small allowance. He mentions that the quantity amounts to 20,464 quarters.

In the Drill Husbandry it can be known what the produce should be, if equally good, by counting the number of ears and grains in a certain space; and what space and quantity of seed yields the greatest produce upon an acre, and can accurately drill that quantity. By this mode of culture too we can form, by means of the crop and number of ears, a more accurate estimate than can otherwise be made, of the difference of the quality of ground, which can be accurately marked so as to improve that part by manure, as mentioned by Mr. Crack, who improved a part of his fields where the crop was always bad.

In the broadcast, what the produce should be of a field cannot be so exactly ascertained; nor what quantity of seed produces the best crop.—In the modes of sowing seed, there may be a difference of several bushels per acre.

Although the proper quantity of seed is accurately sown, the crop depends upon being equally sown, and not more together at one place than another. The proper quantity of seed to be sown, may be sown exactly by means of a drill; and that much more equally too, than it can possibly be by hand,

hand, which every farmer must see is far from being so in his own farm.

But before machines were invented, men had nothing but their hands; and before the invention of spades and ploughs they must have lived as the Indians and beasts of the field, upon the natural produce of the rivers and the woods. Then why not use the improvement of the drill to sow with, as well as the plough in place of the spade?

Many are of opinion, that two additional ploughings are equal to a common manuring. This it must be confessed, cannot be given but by fallowing and losing a crop, to which some are averse. But they ought to consider that they are at a much greater expence for manuring, than twice the year's rent and labour, to gain (as they suppose) a little present profit by a crop, rather than a greater the succeeding years, by the ground being improved and cleaned and free of weeds. In the drill husbandry, however, this additional ploughing is given without the loss of a crop, as it is given when the crop is on the ground, and at a much less expence than so many ploughings to a fallow; and much less than manuring, which is more than the expence of several years culture of drilled crops.—As it is shewn that all the expence of drilled crops is only equal to two common ploughings, in the whole for ploughing and hoeing; and were it double, the four additional hoeings are only *four* shillings. But one manuring is, in many places, as many pounds. The one can be given, but not the other, in the quantities the broadcast farmer could wish, as in many places manure cannot be purchased at any rate.

Many frivolous objections are made to this husbandry, that it is almost needless to answer: Such as, "It would be a loss if the practice of the drill husbandry should ever become general." It must become so, only by being found more profitable. If it
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became the general practice to sow wheat in this method, there would be more wheat produced, as a very great part of the wheat in England is upon fallow. This proportion now in fallow, would also be in wheat, or other grain, and continued in successive crops; by which the quantity would be increased. And in place of a crop of wheat and a fallow, or an inferior fallow crop (suppose fifty acres of wheat and fifty fallow) there may be an hundred in wheat every year, or other grain.

Some object, that if this system was general, there would be no barley, oats, or grass. Before it could have such an effect, it must be much superior even to what the approvers of that husbandry suppose it to be, before it could get so much the better of prejudice and custom.

No doubt, were it found to be so much superior in point of profit to barley or grass, there would be more wheat; but to suppose a farmer was to sow wheat and have no grass for his cattle, would be to suppose him very injudicious.—Grass a farmer must have, for his working cattle, and also hay. But if drilling wheat was supposed so superior, he would not be obliged to lay down so much grass, as many are under the necessity of doing, because the land is impoverished and will not produce corn. It is but poor crops of grass too, that are reaped from such ground. But what quantity of grass was necessary, would be upon ground in good order; and a much smaller quantity would produce more than such exhausted ground does at present.

If grass for cattle were more profitable, and feeding cattle brought the farmer more profit (which in many situations may be the case) the judicious farmer, who understands that branch, would certainly not give up a more profitable branch of farming for one that is less profitable.

In most farms there is ground that would be more
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proper for other grains and grass, and improper for wheat. Drilling wheat by no means excludes barley, as drilling barley is found a profitable manner of cultivating it, as well as all other grains, by many examples stated of the comparisons of the two methods. In many soils, and in some years, barley may be the most profitable.

In many corn countries, the whole farm is in corn of different kinds; and no more grass is grown than would serve the cattle in summer, and for hay in winter. This requires much manure, to encrease which, recourse is had to turnips, which (as is shewn) is a losing crop. It would be more his interest to supply this by ploughing and hoeing, which is done at a much less expence, and he would reap a profit instead of loss, and at the same time improve his ground for the succeeding crops. But several comparisons have already been made in this work, by which it appears, beyond all doubt, that, in such cases, drilling is, by far, the most profitable mode of culture.

From reason, and the many proofs of the hoeing husbandry being the most profitable, and the example of the best farmers in Kent, where furrowing, or drilling is the common method, as is mentioned in Mr. Young's Tour, one would think that farmers would be induced to follow a practice that promises such advantages to the industrious cultivator for his labour and attention; now that the great obstacle is removed, want of proper drills and of strength to be used by every ploughman. But the influence of custom and prejudice is often too powerful for reason; but in no instance more commonly than in agriculture: otherwise in this country, where arts and improvements in all sciences are increasing, one could not but be surprized to see such a variety of ploughs in almost every country, most of which have been the ploughs of that country for centuries;—and such ploughs, that from their construction, one may suppose, were in use

use before the time of the Romans ; and in the next county ploughs are used, so superior in their construction and use, that the one farmer's ground is superiorly cultivated, and at less than half the expence, in the same kind of soil.

It has been urged in opposition to the drill husbandry, that Mons. de Chateaufvieux was obliged to use manure. Mr. Tull advises using manure, as formerly mentioned, where it is to be got at less expence than that of the carriage, and the expences likely to exceed that of the profit.

He says, " that dung with tillage pulverizes in less time:" it is therefore far from being a proof that Mr. Tull's scheme did not answer, although Mons. de Chateaufvieux made use of manure, as it is shewn that the drill and horse husbandry have been continued successfully, without manure for many years, without there being an appearance of its declining.

In the *Museum Rusticum*, vol. 4th, in a letter of Mr. Combers, he says, " Two points have been advanced in the calculations of M. De Chateaufvieux to evince the preference of the new husbandry to the old, which I think will not prove the preference with us Englishmen.

" 1st. That at Geneva, M. de Chateaufvieux says they can have but one crop in two years ; and one crop will fall greatly short of the two, which the new improved husbandry will produce."

This will have no weight with us Englishmen ; for in the common course of our husbandry we have two crops in three years, or three crops in four years ; and though we have not two wheat crops in succession, yet our crops of beans, peas, barley, and oats, are obtained at so small an expence of cultivation after our wheat crops, that no one seems to doubt but the clear profit is greater."

And he mentions the improvements by clover and turnips.

“ 2d. He also states what M. de Chateauvieux mentions, that the produce of what is sowed in the common way, is three times the seed at Geneva.

“ Now if the poorness of the crops at Geneva, be not the effect of want of culture in the old way, every new method which will assist the poorness of the soil, is of consequence to that people; yet ought not we Englishmen to make this point of calculation, the grounds, giving only three for one a preference of the new husbandry.”

It has been shewn by the foregoing statements, that in the drilled land in England, the produce is more, not only than 2 crops and a fallow, or 3 crops in 4 years, but to 4 crops, with fallow crops and clover: and although the intermediate crops of beans, peas, barley, or oats are obtained at so small an expence of cultivation, the drilled is less expence, and more profitable than the Norfolk course which is superior to the former.

The crops of beans, peas, &c. are obtained at one ploughing; but the intention of the drill husbandry was to remedy and supply the defects of the old by a better cultivation and tillage, and not to lessen it by lessening the tillage and ploughing to reduce the expence. This is adding to the defect, and lessening the produce by an inferior culture.

This is not the case in the drilled crops, as the land is not allowed to remain long unhoed, or to grow hard, or stale, but is frequently hoed in summer, and receives the benefit and influence of the atmosphere, and sun, rain and dews, which not only improves the crop, but improves the ground for the reception of the next, and this at a less expence than the broadcast.

2d. The smallness of the crops about Geneva of 3 after 1, does not appear to arise from the want of cultivation in the broadcast husbandry, which makes the drilled superior, as the broadcast is after fallow: but whether it be owing to the soil or climate, the superiority

superiority of the drilled is the same in both places, and is the same in a soil, where the increase of the broadcast is more; therefore the superiority of the drilled appears to consist in the manner of culture, and should be the same in proportion in a better soil or climate, which appears to be the case at Geneva, where the increase is only 3 after 1 after a fallow. The superiority of the drilled appears to consist in the manner of culture, which appears to be the case in England, where the soil and climate appears to be more adapted to grain, where the increase may be supposed from 8 to 10 after 1, in common culture, and we see the increase of the drilled crops has amounted to 40 and 50.

It is certain the same increase cannot be produced from bad land as from good: that the land about Geneva is bad, the small increase shews, and the severe cold in winter may be most unfavourable for this crop, as the land appears bad. Mr. Chateauvieux's applying manure to improve the soil, is by no means a proof that the drill husbandry did not answer, as it was superior to a broadcast on a fallow.

The increase after one, however, is not the proper rule to judge the produce of a crop by, but the produce upon a certain space; for the increase after one depends upon the quantity sown. In some places where they sow 4 bushels, and the produce is 28, this is only 7 after 1; and where they sow only 2, and the increase is 12 after 1, this is only 24. An instance of this is mentioned in the 3d volume of the Bath Papers, where 1 grain, sown at 1 foot in the rows, produced 2184 after 1, and with ears containing 42 grains each; and 28 grains, sown in the length of the foot of the rows, produced only 139 after 1; but the produce upon that space was 3900 grains. The first produced 52 ears, with more grains per ear; but the other 100 ears, with fewer grains. This was in a garden,

garden, and the greatest produce was from a proportion of seed, at the rate of less than 2 pecks and $\frac{3}{4}$ of a gallon per acre. This circumstance of the largest quantity producing the greatest crop, is the reverse in most fields, as many farmers lessen their crop by sowing too much seed, which the ground cannot nourish and bring to maturity.

In Mr. Mills's Treatise of Husbandry he states several things which should be considered.

1st. *We should examine whether all the lands of a farm produce, upon the whole, more corn when cultivated according to the principles of the new husbandry, than the same quantity of land would do, if managed in the old way.*—It is shewn that the drill husbandry produces more corn than the old upon the whole; as in the Norfolk course, there is only 2 crops of corn in 4 years, whereas in the drilled there are 4 crops of wheat; it is also of more value. By the statements of 3 courses of broadcast and drilled compared, it appears that in the first there is in that time 9 quarters 4 bushels of wheat, and 12 quarters 4 bushels of barley, in value 32l. 10s. 2d. and in the drilled, at the medium crops, there are 30 quarters of wheat and in value 62l. 3d. without straw.

2d. *To consider whether the new husbandry does not require so much more expence than the old, as to counterbalance or exceed the profit that may be expected from it.*

It is shewn that the expence and labour is less in the drilled than in the old, even with fallow crops and clover; as the expence of broadcast in these is stated at a medium 1l. 11s. 0d. without rent, and the profit 1l. 7s. 6d. but that of the drilled, the expence is only 16s. 1d. with harvest and rent.

The practice of hoeing turnips in the field is but a late practice, and that of hoeing them is far from being general; although they have the example of gardeners to shew the advantage of hoeing. The same prejudice remains against hoeing grain, though the gardener's

gardener's practice instructs us what may be done in the fields, if we would but follow their experience and practice: and extend the gardener's practice to the farm, as many about London do.

We see the gardener digs his ground in place of hoeing it; and not only so, but trenches it, and finds it even superior to digging. And the gardener, whose land is perhaps twenty times the rent of the farmer's, finds it his interest not only to trench in place of hoeing, but to allow space to his plants. And the farmer who has any experience in turnips, finds the effect of space from the state of that crop. Where they have a reasonable space, they are larger and a greater crop on the field than when they are too thick; and this he allows to a crop, that does not afford a produce of above two or three pounds. Supposing this an expence of ten shillings, besides the space; that is a sixth of the value: but he grudges both upon a crop of three times the value, which, if it encreased the crop one tenth, would be much more than the other.

No doubt the produce of a garden may be supposed more valuable, and such as may afford greater expence; but as space, trenching and digging, increase the gardener's produce in his high-rented land, so it will also increase the farmer's, whose rent and expences of deep-hoeing is proportionally lower.

The numerous gardens and fields around London, where the crops of all kinds are in rows or drills, is a proof of this; and a strong instance is formerly mentioned from vol. 5. of Bath papers, where a gardener raised eight crops in four years, and the land was thus cultivated for twelve years without manure.

As the farmer has but one crop in a season, much less puts his land in order for that, than the repeated crops the gardener raises in a year. This may be supplied by labour alone, as we see from the practitioners of the drill husbandry. And this husbandry
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may be so far imitated in the fields by horse-hoeing, and trenching (where the staple will allow it) by one plough following another, which we see may be done at as small an expence, as one hoeing; and the space at so small an expence as three-pence for every foot of breadth added to the ridge.

We see what great crops rich ground will produce; which would afford much greater expence and amply repay it. And until land is brought to this degree of culture, it is not in the highest degree of perfection it is capable of.

The garden culture, we see strongly recommended by Mr. Millar, and shewn by the many instances he gives of the practice of it, not only in wheat but in barley and turnips. The information so intelligent a gardener gives, and his recommendation of it, should have more weight in recommending it, than unfounded reports of those, who, from particular reasons, wrote against Mr. Tull's System, many of which are still handed down to this day and believed, even by so intelligent an author as Mr. Millar, who says, "Mr. Tull practised this method of sowing the same species upon the same ground till his crops failed, and were much worse than those of his neighbours, who continued the old method of husbandry, and thereby his horse-hoeing husbandry was ridiculed by them, and laid aside by gentlemen, who were engaging in it."

Mr. Millar, it would appear, had given credit to reports handed down, without having examined the Addenda and Additions made to his Essays, where Mr. Tull contradicts many of the false reports.

In the Supplement he says, "There is now the eleventh crop of wheat on the same field."

And in the Conclusion, "The twelfth crop of wheat upon this field was the best, I believe, that ever grew on it; it has now the *thirteenth* crop likely to be a very good."

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He also says, "The crop of six score acres of wheat that was growing at the time of publishing my Addenda was much greater than the crop the year before it."—He further adds, "the same six score acres, which were in wheat last year, are now planted with wheat, and all of it as strong and likely for a good crop as in any of the former years, though there is but about one acre of it dunged. I can shew at this instant one of the experiments I recommended, which, though it be less than two perches of ground, must convince every man that sees it (and doth not renounce the evidence of his senses) that pulverization by instruments can vastly exceed the benefit of common manure, assuring the public, that in all my practice, which is now thirteen years, I never have met with one instance that gives me the least supposition of the truth of the principles I have advanced, and that I believe they have nothing to fear from enemies, but the false relation of facts, or fallacious arguments." This shews Mr. Millar had not seen these additions to his Essays, and how unjust the report was that Mr. Tull's crops had failed.

Some common farmers are so accustomed to weeds, that they do not imagine they hurt their corn. But every gardener and planter knows, that weeds rob trees of a great deal of nourishment; and they find that digging promotes the growth of trees, and that a plantation that is dug and cleaned from weeds is much more thriving and luxuriant than one that is not. As weeds are found to hurt so strong a plant as trees, much more so are they hurtful to corn and grass. Thus we see, from the stubborn oak to the tender grass, attention and care are necessary to destroy weeds; and no method yet known is so effectual, and so easily accomplished, or at so small an expence, as the horse-hoeing husbandry.

The principles of the drill husbandry are so little

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understood, or the cause of the advantage of it known, even by those whose knowledge might have been supposed better, that some who have attempted drilling have been so ignorant of the principles as to drill without hoeing, and in close drills of six or eight inches : as if a drill machine, or the sowing in rows alone was to have the effect the drill husbandry was represented to have, which is much the same knowledge as may be too often found in the common husbandry ; where an intelligent farmer, who understands what he is doing, ploughs his ground well, and keeps it free from weeds and in good order by frequent and good ploughings and proper manuring, by which he succeeds in raising good crops.

His neighbour desires to do the same, and copies his practice by sowing the same crops, and at the same season ; but not being intelligent, his ground is badly ploughed, and not so often, and is full of weeds, and his manuring but one half. His success being much inferior, or rather extremely bad, he blames the method as bad ; but never dreams that the fault lies in the execution.

The same must be the case with those who attempt drilling, and do not understand the principles, and attempt to copy that of others, and do not copy it exactly.

It has been shewn that Mr. Tull, and others, who followed his principles, not only allowed space for the plants, and hoed often to keep the land clean, but ploughed and hoed deep, by which there was a much greater surface exposed to the air and atmosphere, as well as a greater depth of earth properly and well pulverised and made fine to allow the roots to extend. And by Mr. Duckett's method of drilling (as mentioned in the *Annals of Agriculture*) who drilled in equal distant rows at nine inches, and hoed or skimmed, not deeper than hand-hoeing. As the vegetable nourishment must be more exhausted

hausted by these close drills and shallow hoeing, notwithstanding his manuring, he trench ploughs, whereby the surface is ploughed down and rests for some time.

If any man were to copy these methods, and omit to allow space and deep ploughing and hoeing, or to copy Mr. Duckett's, and omit the manuring, trenching and hoeing, he would certainly find these succeeding crops much inferior.

But to such want of information and want of attention in copying the practice of others, is owing the bad success of farming that is to be seen in many places in England; therefore, it is not surprising to find the first attempts of this husbandry badly copied, and consequently not successful.

Where farmers do not act from knowledge, but are only copyers of what others do, they should be very accurate in their imitation, as what they omit may be much more material than their want of knowledge allows them to suppose.

Neither in this husbandry, nor in any other, is it to be expected, that bad land, or land in bad order, can produce crops equal to good land, or land in good order. This is often the case with experiments of the drill husbandry.

Mr. Tull and others, who had good crops, raised them upon land put in good order by repeated drilled crops.

But some who have tried experiments of Mr. Tull's husbandry, have tried them upon land in bad order, and have been much disappointed, to find their crops much inferior to those of other practitioners.

Not attending to the situation of the soil, there being a first crop upon ground not put in order, and not properly hoed (as it cannot be expected by servants who had not practised it before) and the other with which they made the supposed comparison, were crops produced by those who had practised it for many years, and

upon land put into good order, such a comparison is not just. But from such experiments and comparisons, the drilled husbandry is looked upon as bad, and the practice of others is exaggerated: an instance of this I had. A neighbour wished to drill an acre; he had his land ploughed, and, as his ploughman said, made fine: my ploughman went and drilled it, and his report was, that it was so rough that it was only fit for a strong plough, or harrows to go on it, but not for a drill.

The consequence was, that he had an indifferent crop, and never tried it more, from believing the fault was in the system of drilling; whereas the fault lay in not making the ground fine, and its not being properly hoed.

To do the drill husbandry justice, those who try experiments of it should continue them for three or four years; to let their servants learn to execute the hoeing properly, and to prove if the crops are not much better than the first, and such as Mr. Tull's and others.

One may without expence, or risking much, make the experiment upon a small patch of land in any of his fields.

Many other objections are made to the drill by those accustomed to the old husbandry, who cannot divest themselves of the ideas of the practice of the old, which is by no means connected with the new.—The proper comparison is between the two methods upon an equal quantity of land in tillage, for a course of years; the one to be conducted in the most profitable method of the old; and the Tullian, or horse-hoed, as compared above by Sir Digby Legard and others.

It is objected by some, that the men and horses are employed in hoeing in the busy time of hay-making and harvest.—The answer is: it is no part of the drilling system to have more hay or grass than necessary to supply the
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the horses employed for this husbandry, for which a few acres are sufficient.

The teams for hoeing cannot be employed in any thing of so great consequence as the hoeing itself, and should be employed only in that when there is any thing to hoe. I can hardly suppose a farmer so bad an œconomist, as to stop a team to employ the ploughman at hay-making, to save the wages of a hay-maker.

By the state of the drill husbandry, the hoeing is all over before harvest, and the horses are employed in taking in the harvest, before the ploughing for the next crop; therefore there is no interruption in harvest from hoeing.

To have more hay than will serve the horses is not necessary in this husbandry, although it is in the broadcast; where they are obliged to lay a third, or fourth into grass, because it is exhausted, and will not produce corn any longer, without being laid to grass, or being manured.

This is not the case of the hoeing husbandry; as the ground is in great heart, it will produce great crops of grass; therefore a very few acres are sufficient to supply grass and hay for the horses necessary for a farm in the horse-hoeing husbandry, as formerly stated.— One pair of horses manages eighty acres, and after drilling the wheat, they can cultivate a considerable quantity of spring corn.

Raising corn for horses, and great quantities of grass is a different system, and not connected with this; and as it is distinct from it, should be executed by separate servants, and horses belonging to the broadcast part of the farm.

Therefore, the above objection is not an objection to the drill husbandry, but to what they connect with it, which does by no means belong to it, as it is a drill farm alone that is now in question. The busy time
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and hurry of a broadcast farm at particular seasons, do not take place in the drill husbandry.

If the farmer has a part drilled, and a part broadcast, that in broadcast requires double the number of horses to that of the drilled. The horses and servants necessary for it, should execute the work of that part, and those for the drilled execute theirs, of which hay-making is no part. As the quantity allowed to the ploughs is (we shall suppose) 60 drilled, and $12\frac{1}{2}$ spring crops broadcast, in place of 80 (as stated by the Author of the Scheme) this is $72\frac{1}{2}$ acres per pair of horses; there are at least twice the number of horses necessary in a broadcast farm of that extent. The drilled does not interrupt the other, as the team allotted requires no assistance from the broadcast farm, to manage double the quantity drilled.

A like objection is stated by others, *that after the broadcast crops are sown, the farmer may employ his team at fallowing, or other work.* If his teams are employed at fallowing through the summer, the labour is the same as horse hoeing in summer, which is fallowing for the next crop: and it is shewn, that the tillage in the drilled is no more than in the broadcast; and the expences are less, and only half the number of horses are required.

If a farmer fallow 50 acres of his land, it requires 25 days to plough it once with two ploughs, if it was four times ploughed, it would require 100 days.

As two ploughs hoe 6 acres per day, two ploughs will hoe the 50 acres once in $8\frac{1}{2}$ days, or four times in 34, which is only one-third of the time, and with 2 horses in place of 4.

If the teams are employed in carrying manure from a distance, the horse-hoeing farmer has little or no occasion for manure, after the land has been properly cultivated in this husbandry, as it is fallowed every year for the next crop.

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By some it is objected, that there will be less straw, and of course less manure for their corn and grass. This is again recurring to what is necessary in the broadcast; but which is not so in this.

Mr. Tull says, "he kept a team to serve a kiln. But although he should give that up, he should have the same quantity of wheat."

It is shewn, that the land is more exhausted by the broadcast crops, by being obliged to have so great a proportion laid in grass, notwithstanding that they keep a much greater quantity of horses and cattle at a very great expence to procure manure by having turnips.—This is not necessary in the horse-hoeing, as it produces repeated successive crops for many years, as above mentioned, without manure.

These objections are blended with the practice of the broadcast; they do not apply to the drill husbandry. The fair comparison is such as Sir Digby Legard states, when both are fairly compared.

It is objected that clay land cannot be drilled. No doubt clay is more difficult to cultivate; but not more so in the drill, than the broadcast culture.

If clay is fallowed, it must be allowed, it may be sown broadcast. In that situation it may be drilled.—And the horse-hoeing in summer prevents its being stale and hard, and not so difficult to plough after harvest, as the broadcast farmer's land; and it will be as fine as a fallow; and the narrow ridges keep it much drier than the broad ridges.

On clay it is more critical to hit the time of hoeing; as wet weather may delay it longer than loams.

Most clays, when wet, rise in large pieces when ploughed, but not so much so in the drilled, as the broadcast tillage; as it is finer by the hoeing, and the same as a fallow. The broadcast farmer finds clay hard and stale, and difficult to plough the first time after a crop; and as the drilled crop is sown upon once ploughing, and he is not acquainted with the
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state of the drilled land, he naturally supposes it to be in the same state as the broadcast upon once ploughing: but the hoeing prevents it being hard; therefore it is in a very different state, and in that of a fallow.

But we see by what is mentioned by the Rev. Mr. Dean, that it appears his was such a soil, "being bound up like iron, as not to be touched with a plough; and sometimes all in a pap." Yet he drilled this ground above twenty, and continued it several years after. He further adds, "His crops were equal to the sown crops of his neighbours."

Some clays, when made fine, run together with rain; and when dry, bind as hard as iron, so that the stems cannot get through it. I have lost a crop of wheat by this in the broadcast.

To remedy this, as soon as it is beginning to dry, and that horses can go on it;—rolling it with a spike roller, (or even a common roller) or a pair of heavy harrows, will break this crust, and prevent it binding into one solid crust, and admit the stems to come up. This, as some may suppose, would tear it out so much as to destroy the crop. On the contrary, it will increase it by opening the ground, and putting earth to the roots of the plants. Of this I have seen an instance (not indeed in clay) where a crop of oats was so bad, that the farmer harrowed the ground with heavy harrows (it being late in the season he had not time to plough it) and sowed it with barley. The barley soon appeared; but the oats appeared much stronger, and in a short time destroyed the barley. The oats were a remarkable great crop, and the straw was remarkable long, and in clusters of 20, or 30 stems together, from the seed or roots having been dragged into hollows, and covered with fresh earth.

And when beans appear thin in spring, it is the common practice to harrow them, by which the crops
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are found to be improved. This effect may be produced partly from destroying the weeds, and partly by giving fresh earth to the plants, which we see is the case in drilled crops.

Many who have made trial of the *horse-hoeing husbandry*, have done it upon bad land. Such was Mr. Tull's, Sir Digby Legard's, and Mr. Anderdon's; although their produce was small, it was equal to that of their neighbours upon such land; and who had only one crop of wheat in four years: but in the drilled he had four of wheat.

Upon such ground, the crops in any husbandry are much inferior to what is produced upon good land.

But I have heard it improperly used as an argument against the *drill husbandry*, that neither Mr. Tull nor his followers had crops equal to many broadcast.

This is an improper comparison; so is it also improper to compare for one year the produce of a drilled crop with a broadcast crop, (even upon the same land) where the one is perhaps fallowed and manured, at an expence of 5*l.* or 6*l.* per acre, and the other at only 4*s.* 6*d.* for space, and 4 or 5 shillings for hoeings: or to compare crops upon good land with Mr. Tull's or Sir Digby Legard's, which was bad.

It has been unfavourable to this husbandry, that none have tried it upon good land.

But so far the drilling equal distant rows has shewn that great crops are to be obtained by that method upon good land, but much inferior crops are produced upon bad land in this as well as in broadcast.

Having collected many of Mr. Tull's experiments, I shall conclude with the notes to his preface, p. 244; where he says,

“ If mountainous expectations have been raised, it was by others, and I should not have been an-

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swerable for such a production being disproportion-able to these expectations, unless I had fallen short of what I had promised in my Proposals, or title to my Essays. As to both which I hope I may be justified, if allowance be made to the inadvertencies that happen to the pen of a person in pain. The following are all the Articles of my Proposals :

1. " In treating of roots, 'tis proved they extend horizontally to a much greater distance from the stem than is commonly thought; and that they are in this and all other respects by nature adapted to receive the benefit of the horse-hoeing husbandry.

" 2d. The natural and artificial pasture of plants are described.

" 3d. It is shewn how this artificial pasture is raised by dung and by tillage, and what difference there is between one and the other means of raising it.

" 4th. That deep and proper hoeing is a sort of tillage that can supply the use of dung; and it is for want of tillage that few plants are brought to their full perfection.

" 5th. The rules for putting this husbandry in practice are shewn as far as the author's experience reacheth.

" 6th. All the particular instruments are described, with directions how to make use of them. Had I failed of performance of any of these Articles, Equivocus would have been sure to upbraid me with it."

Those who are inclined to examine his Works, may satisfy themselves, how in his Essays he has fulfilled what he there mentioned; they should examine his folio edition, which has in his notes, or Supplement, Addenda, and Conclusion; as the octavo edition, in omitting his Answers to his opposers, also have omitted several of his Explanations of his Scheme.

The fair result of these Observations seems to be,
1st. That

1st. That Mr. Tull and his followers have proved, that by their mode of culture they can make land produce good crops without manure.

2d. That in the horse-hoeing husbandry, the land is every year growing richer, and is in better heart under successive crops, which in the old husbandry grows poorer and poorer, 'till at last it will bear nothing.

3d. That in the horse-hoed with two rows upon ridges from four to five feet broad (as well as equidistant rows) as great crops are produced as in the broadcast.

4th. That successive crops of wheat are obtained in the horse-hoed, which there cannot be in the broadcast.

5th. That the expences are less than the broadcast.

All this is clearly proved by authentic experiments fairly stated, which cannot, I think, leave a doubt of the solid advantages to be reaped by the country, were this mode of husbandry brought into general use.

They who doubt these facts should confute the authors from whom they have been collected, by repeating the experiments as far as they have opportunities, or convince themselves of the justness of Mr. Tull's principles and practice by their own experience and observation.

In this husbandry, those who drill in narrow drills or equidistant rows, have advanced so far as to prove his first practice in that method just, concerning which they were equally incredulous.—And upon trial it is also hoped that they will find his second the same and more profitable.

With a view to contribute to this end, these experiments and the practice and method of performing this husbandry have been collected.

That it requires no extraordinary skill in the ploughman, since when once the ridges are formed

(which every ploughman can do) in the hoeing to and from the rows, they cannot go wrong; as the crop on one hand, and the hollow furrow on the other, are clear and sure guides for their direction.

And now that drills are made sufficiently strong to be used by those accustomed to strong instruments, it may be executed with ease by any common ploughman.



CHAP. XII.

PLOUGHS, DRILLS AND HOES.

THE method of dibbling and drilling grain had been practised long ago, and attempts to revive that method have been tried and mentioned by many writers.

Mr. Worledge, in his *System of Husbandry*, published 1681, says, "Setting corn seems to be very ancient, and hath been a long time attempted to be brought into practice again, as appears by Mr. Platt's *Adam's Tool* revived, printed in the year 1600. He gives the reason why corn sown in the common way yields not so great an increase, as it doth by being set."

"Then Mr. Gabriel Platt succeeds with his better method of setting corn, which he describes:"

Mr. Worledge then describes, and gives a plate of a better engine for sowing the seed in rows. It is upon

upon four wheels, with a hopper above, from which the seed falls upon a spindle, from which it falls into a pipe, that conveys it to the back of the share, which is below, and makes the furrow.

Lord Verulam, Viscount St. Albans, in his Natural History, called the Century of Inventions, published in 1626, says, "To increase the crops of plants, there should be considered not only the increase of the richness of the earth, but the saving of the seed spilt. They have lately begun to set wheat, which nevertheless hath been left off, because of the trouble and pains."

"Yet so much is true, there is much seed saved by setting, in comparison with that which is sown, both by the keeping it from being picked up by the birds, and by avoiding the shallow laying of it, whereby much that is sown, taketh no root."

In Volume II. of the Philosophical Transactions abridged, is described a drill, or sowing machine, by Don Joseph Luccatelo, as appeared by a certificate of an officer the emperor appointed to see the ground sowed with this machine, and reaped in 1660.

It was presented to his Catholic Majesty, and was tried, and it answered.

Of this machine, Mr. Mills, in his edition of Du Hamel's Husbandry, gives a plate and description.—It is so many cups fixed to an axle, and is turned by wheels.—These cups work in a box, where the seed is gradually dropt from a hopper.

Mr. Mills also mentions an improvement of this machine by Mons. Diancourt, by placing it on shafts, which were placed upon an axle between two wheels. This axle was fixed in the wheels and turned with them, upon which axle were two pulleys with a line extending from the pulleys upon the axle of the wheels to two pulleys upon the axle the cups or spoons were upon, which turned that axle.

These

These were the first machines for sowing corn, or drills, I find mentioned; and from these all the others are taken.

Mr. Mills proposes one of these to be placed upon a four-wheeled machine, such as Mr. Worledge describes.

Mr. Tull was the first who went so far out of the old track as to practise drilling to any great extent, and with great success.

He contrived a drill first for St. Foin in 1701, and practised sowing that on two different farms before he went abroad for his health in 1711.

In the notes on the Preface to the Specimen published in 1730 (and mentioned in the notes, published in 1736, with the Essays,) he says, "This drill planted that farm better than hands could have done; and thirty years experience shews that St. Foin thus planted, brings a better crop, than when sown, and lasteth longer." And in answer to some, who said, he had brought it from abroad: "It is well known I had planted two farms with St. Foin before I travelled, which was not until 1711, above ten years after making my drill. The praised commentator on the Georgic can testify this, he having twenty-seven years ago seen the fields of my last farm planted by it, in rows. I gave one to a neighbour who used it in his fields every year whilst I was abroad." He further adds, "the drill has also been used almost as long in planting most sorts of corn for hand-hoeing, and these nine years for horse-hoeing."

He made many alterations to this drill, as he varied his experiments of horse-hoeing, he sometimes drilled two rows of wheat, and tried three or four rows upon six feet ridges. His last alteration and improvement was to drill only two rows, upon ridges 4 feet $8\frac{1}{2}$ inches, or 14 in the breadth of an acre.

His

His drill appears to be accurate in the delivery of the seed : but the construction of it is too nice to be made by common workmen, so that few of them could be found.

As there does not appear to have been any farmer before Mr. Tull, who practised drilling to any great extent, it is therefore called his husbandry.—Many other drills have been invented since his time. He died about 1741.

Several of the followers of Mr. Tull (abroad) have practised that husbandry to great extent, and contrived drills and horse-hoes.

Monsieur Chateaufieux contrived one, which is thought to be too complex to be made by common workmen.

Monsieur Du Hamel contrived one, more simple and easier made.—It was a barrel with holes in it to drop the seed. This has a defect of dropping less seed when full, than when little seed is in the box.

Mr. Crack, an extensive practiser of this husbandry, contrived one upon the same principle as Mons. Du Hamel's, with seed boxes, turned by a strap from the wheels, with holes for dropping the seeds. These were made to remedy a fault of Mons. Du Hamel's; which was the unequal delivery of the seed, as it delivered more seed, when near empty, than when full; as the pressure of the seed, when full, prevented the seed dropping so freely, as when near empty; this was remedied by an hopper: and thereby the boxes have always the proper quantity of seed in them.

In Miscellaneous Dissertations on Rural Subjects, is another plough upon the same principle; a barrel delivery, where the inequality of dropping no more seed, when full, than when there is less seed in the box, is remedied by bars in the seed box, to prevent the pressure of the seed upon what is dropping at the holes.

There

There is lately published a drill plough, upon the same principle of delivery, where it is regulated in a different manner by cross bars, within the box, or barrel. This sows all kinds of seed and grain, and any quantity, and at any distance.

In the *Annals of Agriculture* is one by the Author, that appears to have the same defect as *Monf. Du Hamel's*: and also several that there are patents for:—among which there is one by the *Rev. Mr. Cook*, constructed after the manner of *Don Luccatello's*, with spoons upon an axle. This appears to be much approved of by practical farmers. It is formed for drilling equal-distant rows, at 9 or 12 inches, and at different distances; and may drill upon a ridge for horse-hoeing. It has the merit to get the better of the prejudice of farmers, as a great many have been purchased, and considerable quantities of ground have been drilled with it, as *Mr. Cook* (I am informed) had them sent to different places to shew the effect of them to the farmers upon their own ground; which is the only method to convince practical farmers.

Mr. Tull, *Du Hamel*, and other writers on the subject, may convince intelligent readers of the advantage of this husbandry; but books cannot convince a practical farmer, who does not read. It is only shewing him a better crop upon his own land, that will convince him any other mode of culture is better than his own. This the patentee of this drill has the merit of having done, which has greatly extended this husbandry, which neither the writings of many intelligent authors upon that subject, nor the experiments of *Sir Digby Legard*, *Mr. Dean*, &c. have done. The writings of these authors are confined to a few who read: nor is the practice of the followers of *Mr. Tull* known to any except a few in their neighbourhood; and the bad success of some small experiments prejudice many against that system,

tem, as much as my own experience may have prejudiced me on the other side.—Let others make the experiments themselves and judge.

DRILL FOR HORSE-HOEING.

Drills adapted for drilling two rows upon a ridge for horse-hoeing, I have not seen till of late, made by Mr. Mac Dougal in Windmill-street. They also are adapted to sow five drills at nine inches in equidistant rows upon a ridge of 4 feet 6 inches, or ten drills upon a double ridge by two turns of the drill, and at the same time to harrow them.

In horse-hoeing with a Rotheram plough, the horses going upon the fine land when ploughing from the rows, and by going so near the rows, frequently tread on the plants: and when they walk in the hollow furrow, that occasions the plough to incline so much over, that the furrow is deeper on the one side than the other, which is improper.—Therefore to obviate this, a plough with a bent beam, and a wheel at the end of the beam, was contrived, that the horse may walk in the hollow furrow, and the plough be held upright so as to take out the furrow level at the bottom.

Many other drills are contrived by different artists. Some are contrived like barrows to be wheeled after a plough, and sowing the furrow made by such plough. Such varieties are now constructed, that every farmer may please his own fancy.

From Mr. Tull's drills having been found too slight, many others are now contrived so strong as to bear the roughest usage of those accustomed to handle a plough only. But strength is not necessary for the machine that has only to make rutts one or two inches deep in land as fine as a fallow, and to drop the seed regularly, in the place of sowing by hand.—

B b

The

The use of a drill is not to plough land that is hard by having been nine or ten months without being ploughed—this makes strength necessary for a plough, but it is not necessary for a drill.

Now that the Rev. Mr. Cook's drills have shewn the advantage of Mr. Tull's first method of drilling, by the increase of the produce; it is hoped those gentlemen who have found it so successful, will be induced to try Mr. Tull's last method, which he says is the best. Now that the want of a proper drill is removed, and that some of these Useful Societies of Agriculture will have it tried for four years and compared with equi-distant and broadcast for that time.

In Yorkshire a drill is advertised for traversing the ridges—for which Mr. Heaton has a patent. But in the method of drilling for horse-hoeing in Mr. Tull's manner, upon narrow ridges, there is not that difficulty Mr. Hall mentions in the *Annals of Agriculture*, neither is there any difficulty of drilling upon ridges with the Rev. Mr. Cook's drill and several others, as Mr. Hall mentions with the drill used there for wheat and barley.

But notwithstanding the great improvement of drills, there is still room for greater improvements.

To Mr. Tull's it is objected, that they are too nice and difficult to make; that few can make them; and that the springs rust and spoil.

To others it is objected, that some of them, notwithstanding their being drawn with shafts, and the horse path marked, that he may go straight, it is difficult to prevent the shares being turned aside by clots of grass or even a clover lay, by which the rows are turned zig-zag notwithstanding the utmost attention of the ploughman. Others object, that there is much trouble in emptying them of the seed, as it must be taken out by hand-full's; and that
when

when the field is drilled there must remain a considerable quantity of feed.

Others object, that, as the one end of some fields is of a different quality from the other, it is proper to sow more seed upon one end of the ridges than the other. Now it is said this cannot be done with a drill without much delay and trouble, but is easily done by hand.

Others object, that as accidents may break the strongest drills, they cannot be repaired in the country by common workmen.

But these objections are made by those who have not practised the drill husbandry, or who have not used the new improved drills, in which they are all obviated.

Some of the drills are constructed so, that the shares must go straight, and not moveable to a side, and only higher, or lower.

Some are constructed to be more easily and quickly emptied of the seed; by emptying each hopper at once, in place of taking it out by hand. Some will sow the last ounce in the hoppers as well as the first, or when full.

Some are made to increase, or lessen the quantity of seed to be sown without stopping the machine, and to deliver the same quantity in going up and down a rising ground as on a flat ground.

The drills now made are much less liable to be broken, as cast-iron is more used, and for such parts as are most liable to be broken, or cannot be repaired (as the shares) in the country, a few spare ones may be got for a few shillings.

But in a part of the country, where a great many drills are used, and some thousand acres drilled every year, I have not heard of one being broken.

There is certainly a particular distance of drills and quantity of seed that is most profitable, whether

it is what Mr. Tull directs, or any other. Were the distance exactly ascertained, a drill adapted to that, with few variations, would be best for common use, and strongest; and I have no doubt but ingenious mechanics will contrive drills more simple, which will obviate all reasonable objections made to drills, and that they will be less expensive when the making of them comes into more hands.

Many horse and hand-hoes have been contrived of late of different kinds. There is one for hoeing with men, made by Mr. Mac Dougal, for which the Society of Arts bestowed a premium of 20*l*. It is upon a wheel, from which there is a pole by which men draw it, and it is directed by a man; and by altering the shares, it will hoe different breadths, and also will hoe three nine-inch spaces with three small hoes. See plate II.

A trial of this was made on a sand walk with one man drawing and one holding it. In an hour and a quarter they hoed with the machine the same quantity that two men with hoes were four hours doing.

And on a trial in strong land, two men drawing it, and one conducting the hoe: with an 18-inch hoe, in half an hour, hoed 12 drills of pease, planted at two feet, while six gardeners hoed only 6, which is four times as much as three men would hoe. And the length they hoed by measure, was one mile and a half, or 2640 yards.

As an acre is 220 yards in length, and 22 in breadth, two-feet rows is 33 spaces in breadth, and the length to be hoed would be 7260 yards: as in half an hour they hoed one mile and a half of length; this is nearly at the rate of hoeing one acre in one hour and a quarter; or suppose it requires one hour and a half to hoe an acre: by this contrivance three men would hoe 6 acres in 9 hours. If each man had 1*s*. 6*d*. per day, which is 4*s*. 6*d*. in all; this would be hoeing at the rate of 9*d*. per acre.

The

The following Table shews the number of grain there are sown per yard, or foot, from different quantities drilled; likewise the square inches of space each grain has, as 3 pecks drilled is 28 grains per foot of drills, and has $\frac{1}{10}$ square inches of space for each grain.

Having measured and weighed a Bushel of Wheat

Avoirdupois.

lb. oz.

Breadth of an acre 22 yards		A bushel Winchester		
Breadth of ridges } 14 ridges		weighs	---	61 0
4 f. 8½ inches		A peck	---	15 4
is in breadth		A gallon	---	7 10
Two drills upon each	28			
		One ounce is 676 grains		
Length of ridges	220	Square yards per acre		4840
Drills	28	Two head ridges 22 yds.		132
		broad by 6, deduct		4708
Total length	6160	Length of an acre	---	220 yards
Deduct head ridges 28 } drills at 6 yards each	168	Breadth of an acre	---	22
Double rows	5992 fingle			440
	2996			440
				4840

TABLE

Upon Ridges Four Feet Eight Inches and a Half, and Two Rows per Ridge.

	Sq. inches per grain.	Weight at 16 oz.		Number of grains.	Seed.		Grains per yard.
		lb.	oz.		Bush.	Pecks.	
If there are 15 ridges in the breadth of an acre, there will be 5 grains and half of seed less per yard sown, or 77 grains in 3 pecks of seed.	Inches.						
	$2\frac{3}{16}$	244		2639104	4		440
		183		1979328	3		330
	$3\frac{7}{16}$	153		1649440	2	2	$275\frac{1}{16}$
	$4\frac{1}{16}$	122		1319552	2		228
	$6\frac{7}{16}$	91	8	989664	1	2	$165\frac{1}{16}$
	$9\frac{1}{16}$	61		659776	1		110
		45	12	494832		3	$82\frac{1}{2}$
	$12\frac{6}{16}$	30	8	329888		2	55
	$18\frac{4}{16}$	15	4	164944		1	$27\frac{1}{2}$
	$86\frac{8}{16}$	7	10	82472			$43\frac{1}{16}$
	$73\frac{6}{16}$	3	13	41236			
		1	$14\frac{1}{4}$	20618			
			$15\frac{1}{4}$	10309			
			8	5408			
			1	676			

This Table is exclusive of head ridges, for which are allowed three yards for each, which makes a difference from the measure of an acre.

The head-ridges are 22 yards by 6, or 132 square yards; deduct this, there remains 4708. This is what the square measure is calculated by.

The ridges of a statute acre are 220 yards long, by 22 broad, makes 14 of the above ridges of four feet eight inches and a half, and two rows upon each is 6160 yards of drill.

From this deducting 6 yards from 28 rows is 168; remains to be drilled 5992 yards, which is the measure the number of grains is calculated by.

As in three pecks there are 494,832 grains, divide this by the number of yards 5992; and this gives 82 grains per yard.

Good grain, in some places, weighs 64 lb. per bushel; the average is about 60 lbs.

Common wheat weighed 61 lbs. per	
bushel, and the number of grain	
was	676 per oz.
But drilled wheat is much larger.	
And horse-hoed is still larger; in	
number	600 per oz.

Likewise may be calculated, nearly the produce by counting the ears of some yards taken at an average, and the grains per ear.

As some may be curious to calculate the produce of drilled and horse-hoed wheat, and others cannot believe that there can be so great an increase from a crop with two rows horse-hoed; I have subjoined a Table by which that produce may be reduced to a pretty exact calculation.

By

By counting the ears per yard, as $50\frac{7}{10}$ and multiplying these by 40, the grains per ear is 2028 grains; divide that by 676, the grains per ounce, is 3 oz. per yard: multiply the yards to be drilled 5992 by the ounce, is 17,976 ounces, this divided by 16, gives $1123\frac{1}{2}$, and that by 61, the pound, per bushel, is 18 bushels, 1 peck, 1 gallon, 2 pounds, 10 ounces.

As there are 5992 yards of DRILLED per ACRE.

Ounces per yards of rows, calculated by 40 gr. per ear.	Grains per yard.	Ears per yard.	Per acre.				
			Bush.	Pecks.	Gal.	lb.	Oz.
1 oz. per yard of single rows }	676	$16\frac{9}{10}$	6	0	1	0	6
2 oz. - - -	1352	$33\frac{8}{10}$	12	1	0	1	12
3 oz. - - -	2028	$50\frac{7}{10}$	18	1	1	2	10
4 - - -	2704	$67\frac{6}{10}$	24	2	0	2	8
6 - - -	3056	$101\frac{4}{10}$	36	3	0	4	4
8 - - -	5408	$135\frac{2}{10}$	49	0	0	6	0
9 oz. or 18 per double rows }	6084	$152\frac{1}{4}$	55	0	1	7	6

If there are $50\frac{7}{10}$ ears per yard of single rows; if they produce 50 grains per ear, this is 2528 grains, and 650 grains weight one ounce. The grains per yard divided by this makes $4\frac{1}{8}$ ounces per yard; the yards multiplied by this, and that divided by 16, gives the pounds, and that by 61, the pounds per bushel; this is 24 bushels, 2 pecks, 3 pounds, 8 ounces.

As the horse-hoed wheat has much larger ears and heavier grains, it will much exceed this, although there were no more ears per yard; but by the above direction, every farmer may calculate his crop.

By this it may be judged nearly what a field produces, or what the increase is after one.

But what may be delivered into the granary, depends upon the care and attention of the farmer and his servants, and the honesty of those employed about the

the many operations, and the loss and waste in the barn.

I am informed, that some of these operations may be much shortened by the invention of a threshing machine. The abridgment of that labour will be a great saving of the waste to which it is liable in its present mode, as the farmer may give his attendance for a day to this operation, though his other necessary avocations may prevent his constant attendance, perhaps for weeks, for so much time may be consumed in threshing out an equal quantity of grain in the usual mode of threshing.

Those who wish to be fully informed of the drill husbandry in every particular, may read Mr. Tull; Mr. Forbes's extensive Practice of new husbandry; Miscellaneous Dissertations on Rural Subjects, and Rural Improvements; or, Essays, &c. by a Land Owner.

In these they will find all the objections that have been made to Mr. Tull's husbandry, and the answers to them, as they accurately describe the manner of the different operations which may be of use to those who incline to practise this husbandry.

The number of rows at different distances, in the breadth of an acre of 66 feet.

	Rows.
If flat, and drilled at equal distances at 9 inches and no furrows	88
If at 12 inches	66
If at 18 inches	44

Ridges.	Partitions. Inches.	Intervals. Feet.	Intervals. Inches.	Rows.
If at 3 feet with 2 rows	10	2	2	44
If at 3 feet 6 inches	10	2	8	38
If at 4 feet	10	3	2	33
If at 4 feet 6 inches	10	3	8	29 $\frac{2}{3}$
If at 4 feet 8 $\frac{1}{2}$ inches	10	3	10	28

CALCULATIONS OF EQUI-DISTANT ROWS AT NINE INCHES.

THE breadth of a statute acre is 66 feet; with ridges, as directed for the Rev. Mr. Cook's drill, at 9 feet 6 inches, there are 6 ridges, and 6 double hollow furrows, of 18 inches.

As there are 12 drills per ridge, this is 72 rows per acre.
These at 220 yards of length per ridge is - 15840 yards
Allowing 6 yards from each for head ridges 432

To be sown of single rows 15408

Or of double - - - 7704

In the drilled at 9 inches } by the table is 659776 grains.
1 bushel to be sown

This divided by the yard, is per yard 42 ³/₁₆

The square inches in an acre, after deducting the head ridges, divided by the grains, each grain has square inches 7 ⁶/₁₆

By the table of horse-hoed, each has a space of - - - 12
The nine-inch rows 7 ⁶/₁₆

The nine-inch rows have less space 4 ⁴/₁₆

A large space of earth contributes to the nourishment of the plants, and increase of the crop, as is shewn by instances of grain at different distances, and by the equidistant producing such great crops, in comparison to those of the broadcast, which has not half the space; and, as the nine-inch rows are only hand-hoed superficially, one or two inches, and the horse-hoed are three times that depth, and have near one third more space of surface, are 4 or 5 times thus hoed, the earth much improved by the exposure from the

the manner of hoeing, and withal better pulverized : the horse-hoeing husbandry having all these advantages, causes the ear to be larger, as well as tillering more, and to produce more ears from each grain.— By this the horse-hoed produce bears a greater proportion to the seed drilled.

The following Estimate may be useful to prove that the Expencc and Time requisite in Drill Husbandry are by no means so great as in the Broadcast.

Length of an acre	220 yards
Breadth	22
	440
	440
	4840

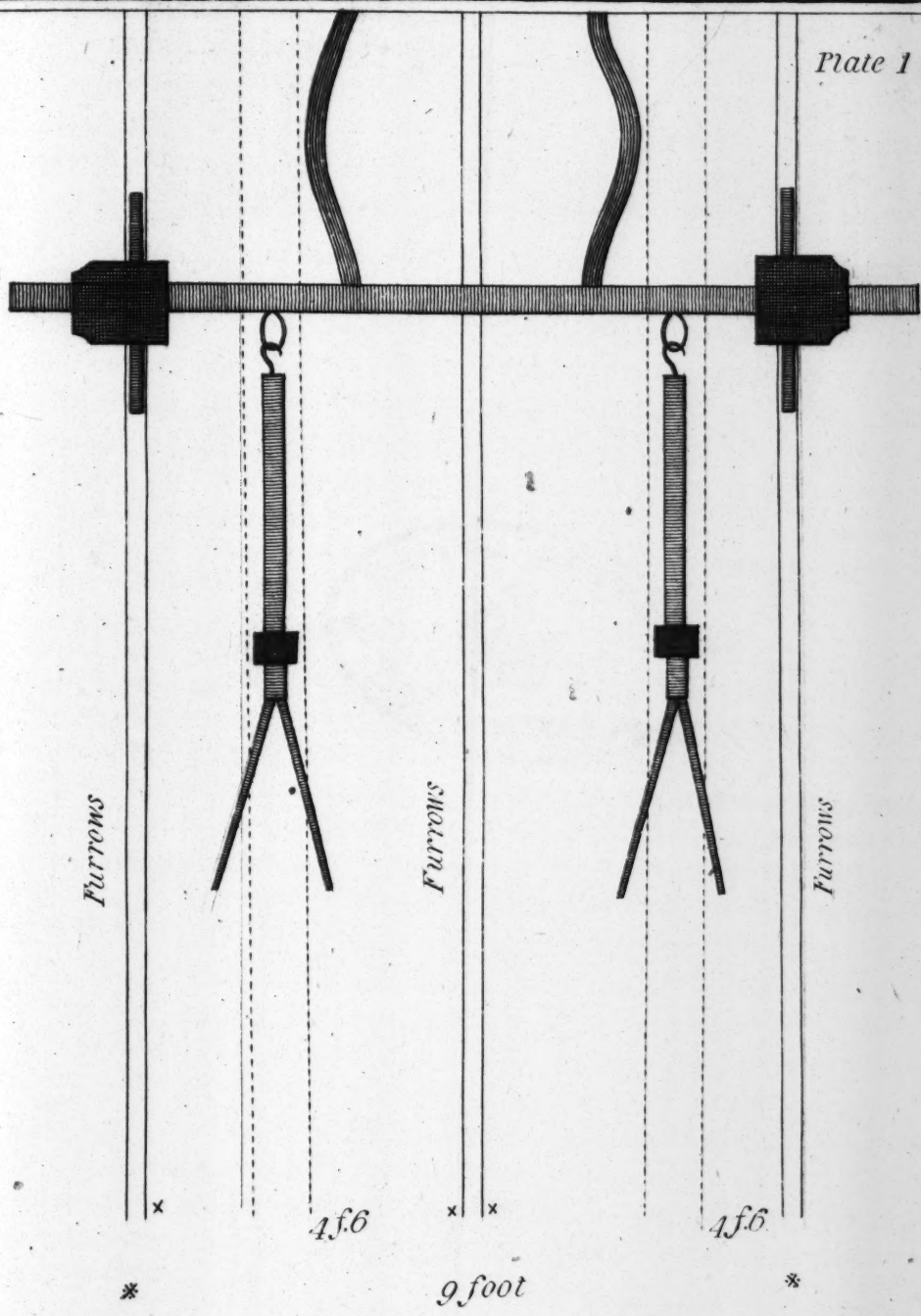
	Hours.	Min.
One bout is executed in	0	10
An acre is hoed in	2	20
In 8 hours 24 minutes 6 acres are drilled	8	24
4 Hoeings is done in	9	20
Forming the ridge is 2 bouts	4	40

	Grains.
3 Pecks of seed is per yard of single rows	82
Of double drills	164
And grains per inch	2½
One bushel per acre, is per yard	110
In double rows	220
Per inch	3
The horse walking one bout in 10 minutes, is one mile and a half per hour, and 12 miles in 8 hours.	

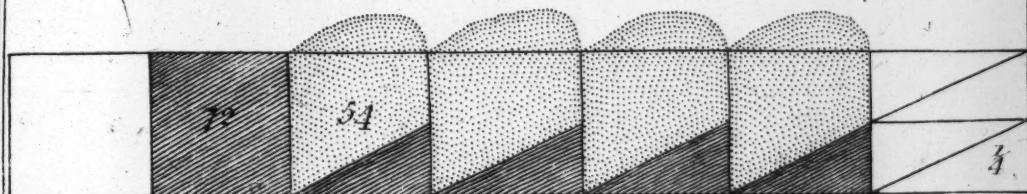
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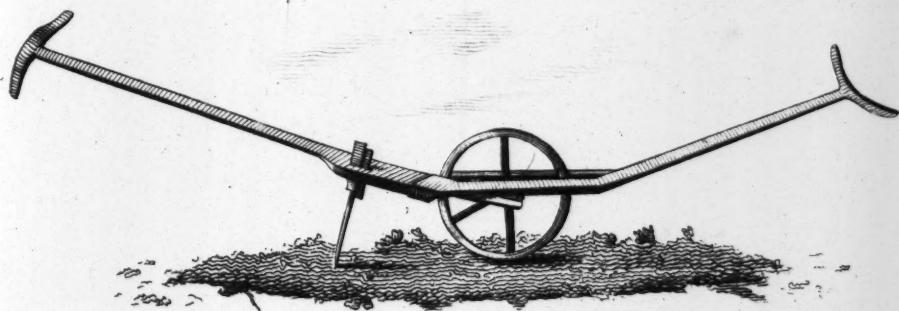






If the Furrows are nine Inches broad and eight deep, and the Plough is held straight, and the bottom level or parallel to the surface, this takes a Furrow of seventy two Cubic Inches .

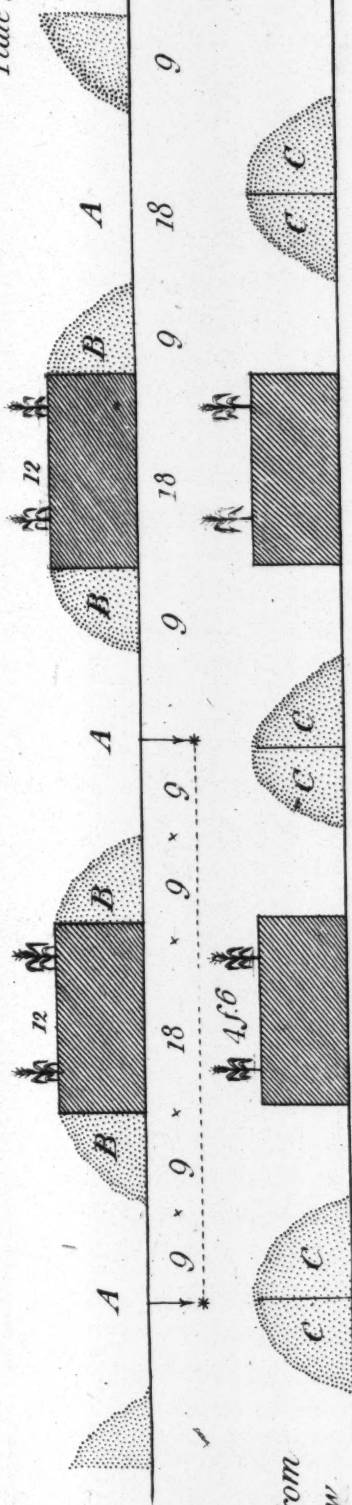
If it is held to the left hand, that the Share is four Inches higher than the Land-side, this makes the depth only four, and the other eight , the Average is six; this multiplied by nine is only fifty-four Cubic-Inches, that is ploughed, or three fourths of the other, by which there is one fourth not ploughed .





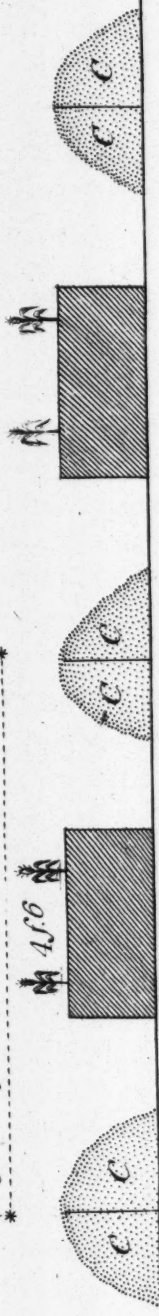
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Ridges



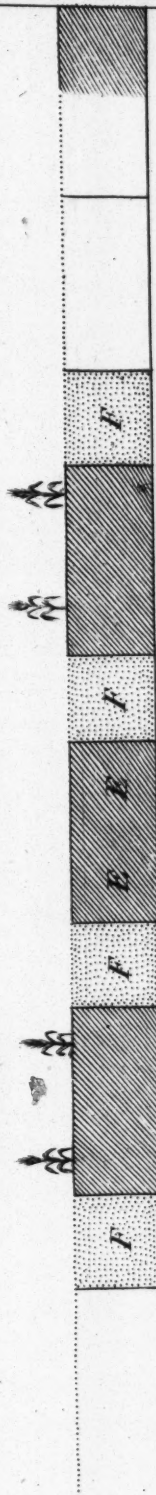
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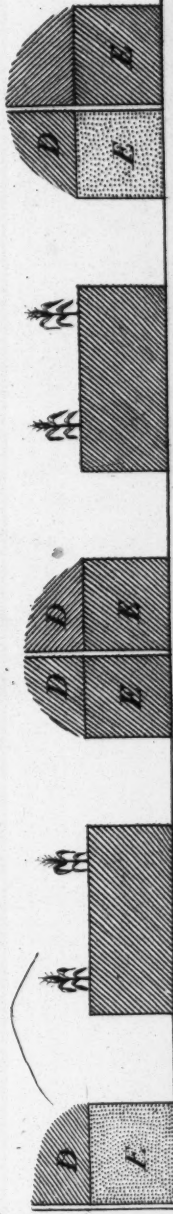
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Drilld
on Flat



4

Hoed from
the Rows

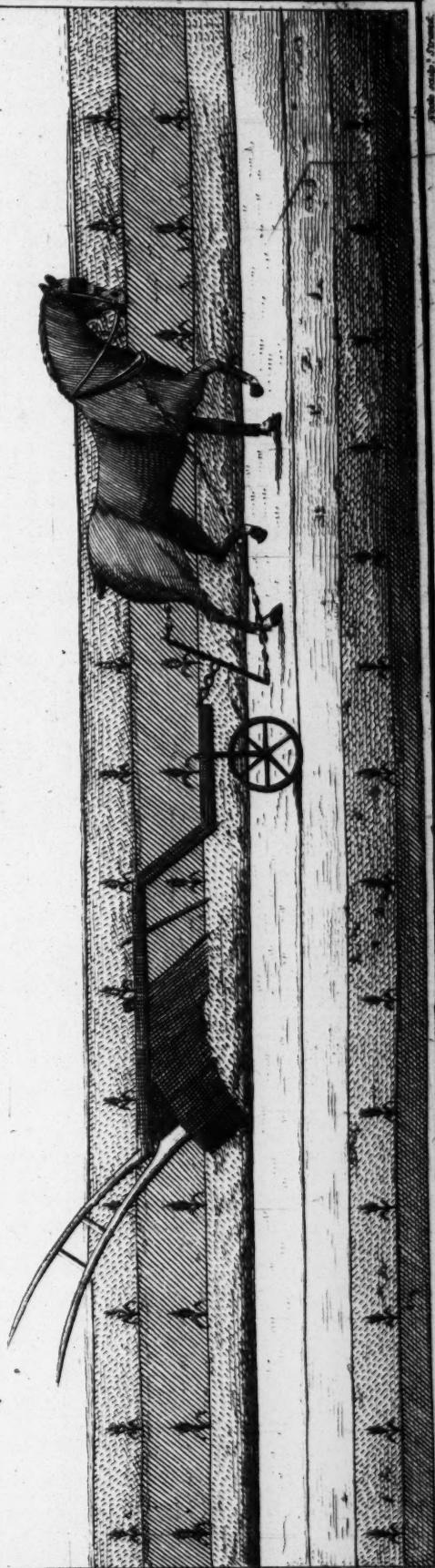


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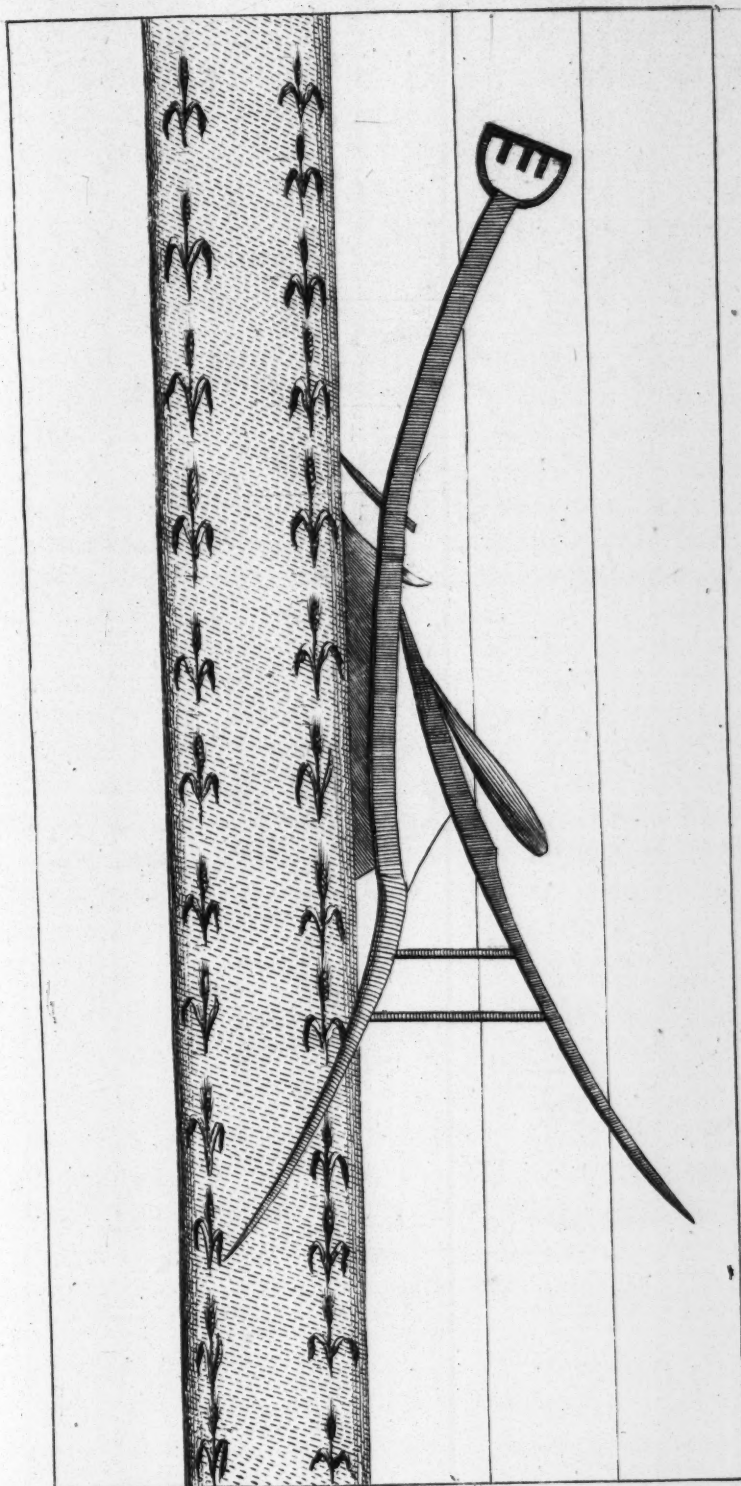
Hoed to
the Rows











*HORIZONTAL VIEW of a Hoe **PLOUGH.**
for Remarks on Drill Husbandry.*

London Published by T. Egerton Feb: 23rd 1796 Whitehall.



